Vol. 1 of 3

Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION
ENVIRONMENTAL RESTORATION PROJECT
SWMUs 16, 228A, 65A, 65B, 65C, AND 94E

September 1999

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico is proposing a risk-based no further action (NFA) decision for Solid Waste Management Units (SWMU) 16, 228A, 65A, 65B, 65C, and 94E. Review and analysis of all relevant data for these SWMUs indicate that concentrations of constituents of concern (COC) at these sites do not pose an unacceptable risk to human health or the environment. Thus, these SWMUs are proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that could have been released from the SWMUs into the environment pose an acceptable level of risk under current and projected future land use, as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998). This executive summary briefly describes each of the above-listed SWMUs.

- SWMU 16 (the Open Dumps in Arroyo del Coyote in Operable Unit [OU] 1309), an inactive site, was used as an uncontrolled trash dump and gravel quarry from the late 1950s to the late 1980s. A radiological voluntary corrective measure (VCM) was conducted at SWMU 16 in 1995 and 1996 (Phase I) and 1997 and 1998 (Phase II). Confirmatory sampling analyses revealed residual metals and radionuclides. The site assessment concludes that SWMU 16 does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 16 were very low.

- SWMU 228A (the Centrifuge Dump Site in OU 1309), inactive since the 1950's, was used for the disposal of weapons debris and construction debris on the northern rim of Tijeras Arroyo. A radiological VCM was conducted at the site in 1998 and 1999. Subsequent sampling analyses revealed residual metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and radionuclides at SWMU 228A. The site assessment concludes that SWMU 228A does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 228A were low.

- SWMU 65A (the Small Debris Mound in OU 1333), an inactive subunit of SWMU 65, was a small concrete bunker (covered with soil) that could have been used for an explosives propagation test at the Lurance Canyon Explosives Test Site (LCETS). A radiological VCM was conducted to excavate and demolish the bunker in March 1999. Subsequent sampling analyses collected under the bunker floor after its removal revealed residual metals and radionuclides slightly above background concentration limits at SWMU 65A. The site assessment concludes that SWMU 65A does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 65A were very low.

- SWMU 65B (the Primary Detonation Area in OU 1333), an inactive subunit of SWMU 65, was the detonation area for general explosives tests, miscellaneous burn tests, slow-heat tests, and the Torch-Activated Burn System Test Location A at the LCETS. A radiological VCM was conducted at the site in 1995 and 1996. Point sources and small area sources were removed in 1995. Larger area sources were remediated in 1996. Subsequent sampling analyses revealed residual metals and radionuclides at SWMU 65B. The site assessment concludes that SWMU 65B does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 65B were very low.

- SWMU 65C (the Secondary Detonation Area in OU 1333), an inactive subunit of SWMU 65, was used to conduct general explosives tests and miscellaneous burn pit tests at the LCETS. A radiological VCM was conducted at the site in 1995 and 1996. Point sources and small area sources were removed in 1995. Larger area sources were remediated in 1996. Subsequent sampling analyses revealed residual metals, VOCs, SVOCs, and radionuclides at SWMU 65C. The site assessment concludes that SWMU 65C does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 65C were very low.

- SWMU 94E (the Small Surface Impoundment in OU 1333), an inactive subunit of SWMU 94, was an impoundment used for several fuel-fire burn tests which may have received wastewater from some portable pan burn tests at the Lurance Canyon Burn Test Site. A radiological VCM was conducted in 1996. Confirmatory sampling analyses performed in 1996 and 1998 revealed residual metals and radionuclides at the site. The site assessment concludes that SWMU 94E does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 94E were very low.

REFERENCES

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, New Mexico Environment Department, Santa Fe, New Mexico.

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOC	area of concern
bgs	below ground surface
COA	City of Albuquerque
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm^2	square centimeter(s)
COC	constituent of concern
CON-CON	Conical Container
cpm	counts per minute
DOE	U.S. Department of Energy
dpm	disintegration(s) per minute
DU	depleted uranium
ECF	Explosive Components Facility
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
EP-TOX	extraction procedure toxicity
ER	environmental restoration
FIP	Field Implementation Plan
g	gram(s)
GEL	General Engineering Laboratory
GM	Geiger-Mueller
HE	high explosive(s)
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HQ	hazard quotient
hr	hour(s)
HRMB	Hazardous and Radioactive Materials Bureau
HRS	hazard ranking system
HSWA	Hazardous and Solid Waste Amendments
ID	identification
JP-4	jet fuel composition 4
KAFB	Kirtland Air Force Base
kg	kilogram(s)
L	liter(s)
LAARC	Light Airtransport Accident Resistant Container
LCBS	Lurance Canyon Burn Site
LCETS	Lurance Canyon Explosives Test Site
MCL	maximum contaminant levels
MDA	minimum detectable activity
MDL	method detection limit
µg	microgram(s)
mg	milligram(s)
mrem	millirem(s)
MS	matrix spike
NFA	no further action
NMED	New Mexico Environment Department
NTS	Nevada Test Site
OB	Oversight Bureau
OU	Operable Unit

ACRONYMS AND ABBREVIATIONS (Concluded)

PCB	polychlorinated biphenyls
PCE	perchloroethylene
pCi	picocurie(s)
PID	photoionization detector
PPE	personal protective equipment
ppm	part(s) per million
PQL	practical quantitation limit(s)
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RDX	1,3,5-trinitrobenzene
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RMMA	Radiological Materials Management Area
RMWMF	Radioactive and Mixed Waste Management Facility
RPD	relative percent difference
RPSD	Radiation Protection Sample Diagnostics
RSI	Request for Supplemental Information
SAP	sampling and analysis plan
SGS	Segmented Gate System
SMERF	Smoke Emissions Reduction Facility
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound
SVS	soil vapor survey
SWISH	Small Wind-Shielded
SWMU	Solid Waste Management Unit
TA	Technical Area
TABS	Torch-Activated Burn System
TAL	target analyte list
TCA	1,1,2-trichloroethane
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
tics	total ion counts
TJAOU	Tijeras Arroyo Operable Unit
TNT	trinitrotoluene
TPH	total petroleum hydrocarbons
UXO	unexploded ordnance
VCA	voluntary corrective action
VCM	voluntary corrective measure
VOC	volatile organic compound
yr	year

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) proposals for six environmental Restoration (ER) Solid Waste Management Units (SWMUs). The following SWMUs are listed in the Hazardous and Solid Waste Amendments Module IV of the SNL/NM Resource Conservation and Recovery Act Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1993). Proposals for each SWMU are located in this document as follows:

Operable Unit 1309

- SWMU 16, Open Dumps, Arroyo del Coyote (Section 2.0)
- SWMU 228A, Centrifuge Dump Site (Section 3.0)

Operable Unit 1333

- SWMU 65A, Small Debris Mound, Lurance Canyon Explosives Test Site (Section 4.0)
- SWMU 65B, Primary Detonation Area, Lurance Canyon Explosives Test Site (Section 5.0)
- SWMU 65C, Secondary Detonation Area, Lurance Canyon Explosives Test Site (Section 6.0)
- SWMU 94E, Small Surface Impoundment, Lurance Canyon Burn Test Site (Section 7.0)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision, as determined from assessments predicting acceptable levels of risk under current and projected future land use.

REFERENCES

U.S. Environmental Protection Agency (EPA), August 1993, "Module IV of RCRA Permit No. NM5890110518-1," EPA Region VI, issued to Sandia National Laboratories, Albuquerque, New Mexico.

4.0 SOLID WASTE MANAGEMENT UNIT 65A, SMALL DEBRIS MOUND, LURANCE CANYON EXPLOSIVES TEST SITE

4.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 65A, Small Debris Mound, Operable Unit (OU) 1333. SWMU 65A was a small concrete bunker (covered with soil) that could have been used for an explosives propagation test at the Lurance Canyon Explosives Test Site (LCETS). Review and analysis of all relevant data for SWMU 65A indicate that concentrations of constituents of concern (COC) at this site are less than applicable risk assessment action levels. A voluntary corrective action (VCA) was conducted to excavate and demolish the bunker in March 1999. The soil and debris associated with the bunker demolition was containerized in roll-offs and disposed of at the Kirtland Air Force Base Landfill. Confirmatory soil samples collected under the bunker floor after its removal indicated that no hazardous or radiological contamination was present at the former location of the SWMU 65A bunker. Thus, SWMU 65A was proposed for an NFA decision based upon confirmatory sampling data and as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

4.2 Description and Operational History

Section 4.2 describes SWMU 65A and discusses its operational history.

4.2.1 Site Description

SWMU 65A is a subunit of SWMU 65, which was identified as the LCETS on the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments permit. The site is located on U.S. Air Force land withdrawn from the Bureau of Land Management and permitted to the U.S. Department of Energy (DOE) (SNL/NM July 1994a). This site is situated on the canyon floor alluvium in the upper reaches of the Lurance Canyon drainage. The Lurance Canyon drainage is surrounded by moderately steep sloping canyon walls, and the immediate topographic relief around the site is over 500 feet (Figure 4.2.1-1). A 25- to 50-foot-wide road cut on the hillsides as a firebreak encircles the site (Figure 4.2.1-2). The canyon floor at the site is isolated by the canyon walls except for the western drainage into the Arroyo del Coyote. Coyote Springs Road follows this drainage and is the main access into the Lurance Canyon (Figure 4.2.1-1).

Because of the complex testing history of the site, the LCETS was subdivided into five subunits as proposed in the "RCRA Facility Investigation [RFI] Work Plan for the OU 1333, Canyons Test Area" (SNL/NM September 1995). The locations of detonations and the types of tests conducted at SWMU 65 were key in determining the five subunits: SWMU 65A (Small Debris Mound), SWMU 65B (Primary Detonation Area), SWMU 65C (Secondary Detonation

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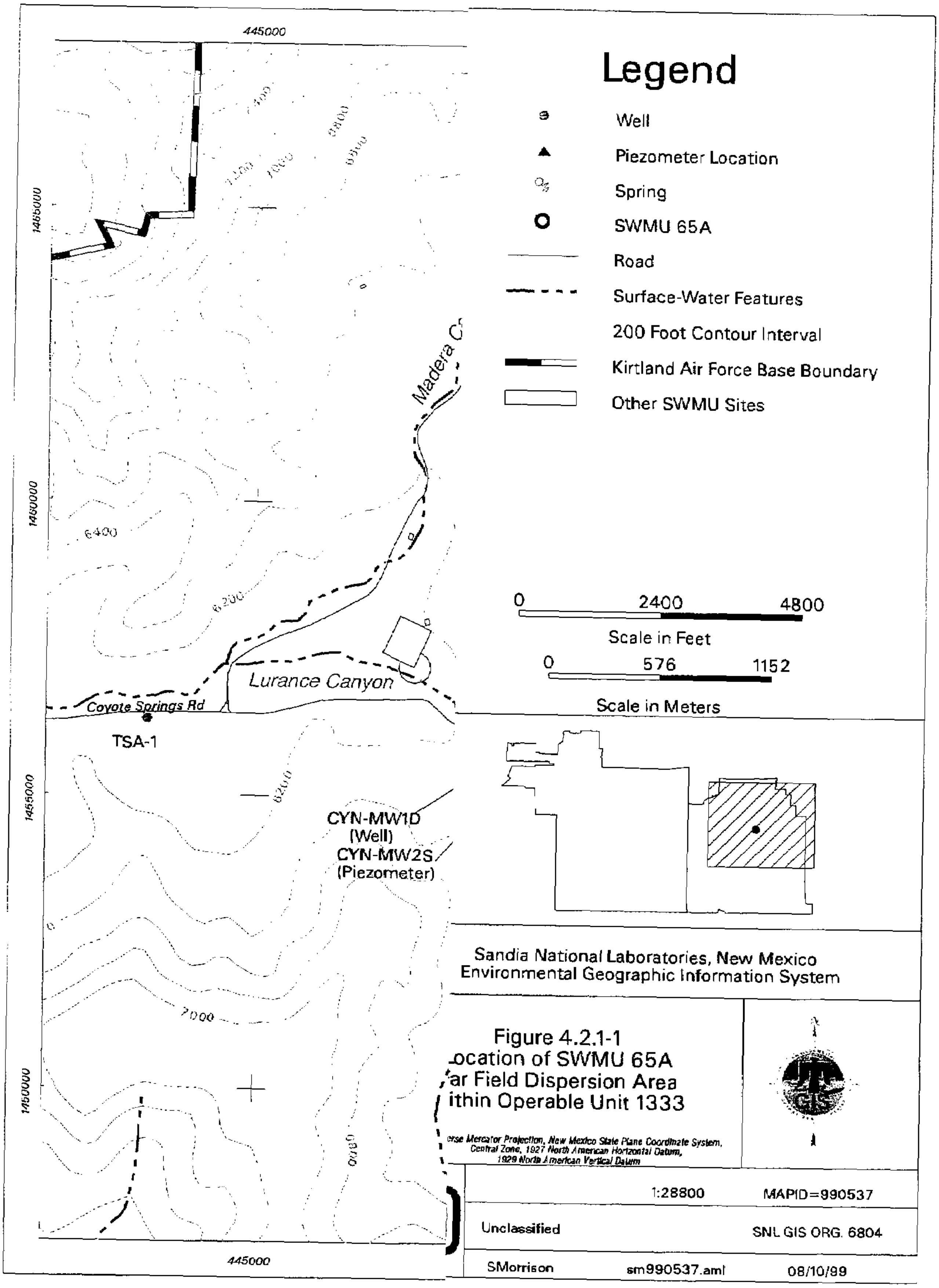
445000
Legend
Well
Piezometer Location
Spring
SWMU 65A
Road
Surface-Water Features
200 Foot Contour Interval
Kirtland Air Force Base Boundary
Other SWMU Sites
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Scale in Feet
0 576 1152
Scale in Meters
1465000
1460000
1455000
1450000
6400
6200
7000
Madera C
Lurance Canyon
Coyote Springs Rd
TSA-1
CYN-MW1D
(Well)
CYN-MW2S
(Piezometer)
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
Figure 4.2.1-1
.ocation of SWMU 65A
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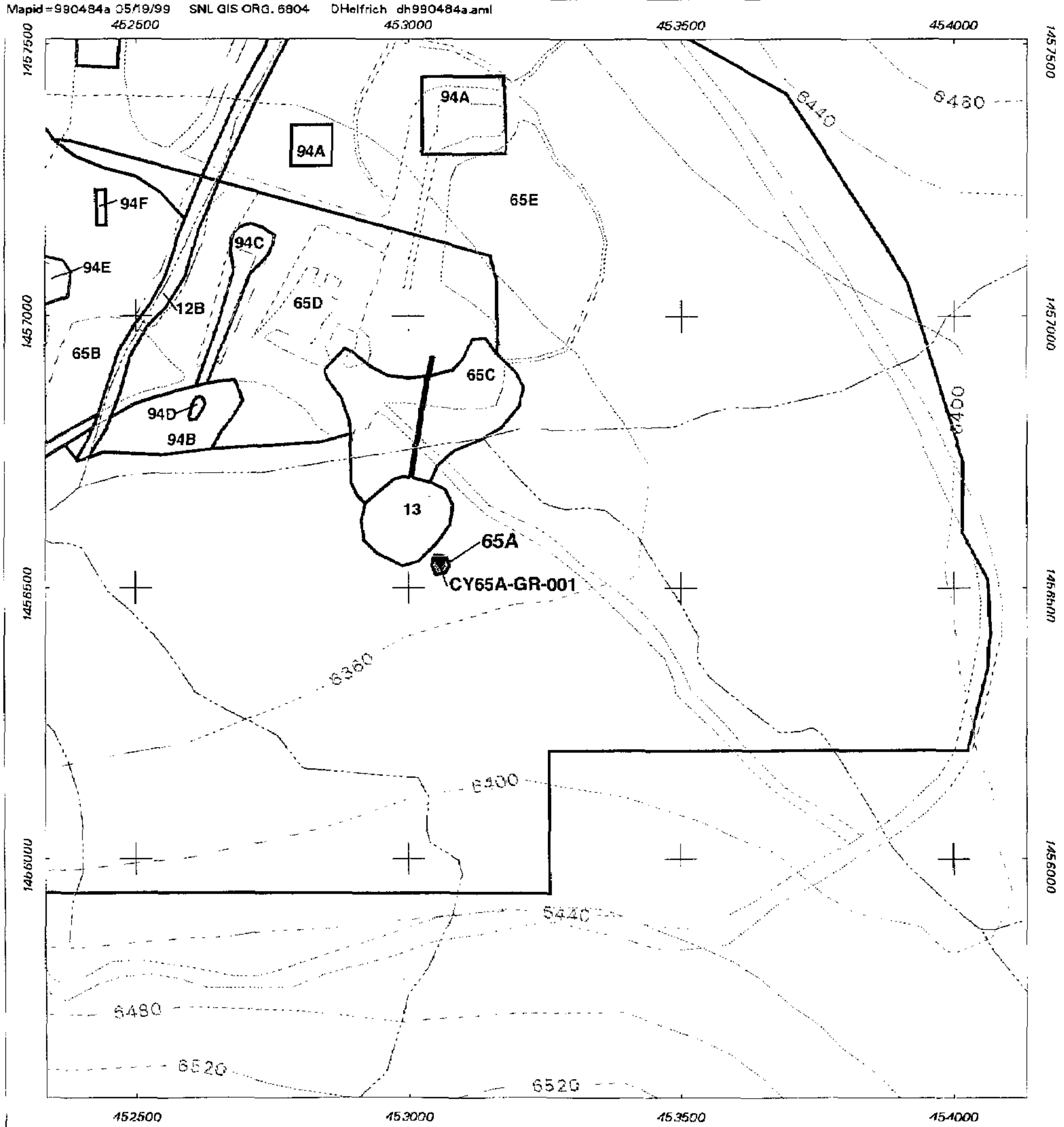
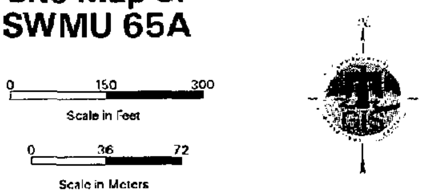


Legend

▼	Scoping Sample
	Road
	40 Foot Contour
	Drainage
	SWMU 65A
	Other SWMU

Figure 4.2.1-2
Site Map of
SWMU 65A



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Area), SWMU 65D (Near-Field Dispersion Area), and SWMU 65E (Far-Field Dispersion Area). Each of the SWMU 65 subunits is addressed in a separate NFA proposal. The NFA proposal for SWMU 65E was submitted in September 1998 (SNL/NM September 1998), the NFA proposal for SWMU 65D was submitted in June 1999 (SNL/NM June 1999), and the NFA proposals for SWMUs 65B and 65C are included in this document.

SWMU 65 is currently an inactive site that was used from the late 1960s to the early 1990s for general explosives tests. It is located coincident with SWMU 94, the Lurance Canyon Burn Site (LCBS), which is actively used for testing fire survivability of transportation equipment, storage equipment, simulated weapons, and satellite components. SWMU 94 activities began in the mid-1970s and continue to the present.

SWMU 65A lies on approximately 0.2 acre of land at a mean elevation of 6,363 feet above sea level (SNL/NM April 1995) and lies on the southeast rim of SWMU 13, Oil Surface Impoundment (Figure 4.2.1-2). The site was originally considered a small debris mound (Figure 4.2.1-3a/b). However, during trenching activities associated with the RFI, it was discovered that the site was actually a small bunker that had been covered with soil. The bunker was constructed of concrete and the interior was lined with foam that was held in place by wood structural supports and metal springs. The interior dimensions of the bunker were approximately 7 feet wide by 14 feet long with a 6-foot interior ceiling. The interior wood and foam was burned, but no major structural damage was visible (Figure 4.2.1-4a/b).

Historical published information regarding the hydrogeology of the Lurance Canyon was summarized in the RFI Work Plan for the OU 1333 (SNL/NM September 1995). Since the time of the production of that work plan, additional bedrock wells and alluvial piezometers have been installed in the Lurance Canyon, and data collected from the new wells support the hydrologic model of semiconfined to confined groundwater conditions at a depth of approximately 222 feet below ground surface (bgs) beneath the Lurance Canyon SWMUs. The data collected from the alluvial piezometers support the absence of alluvial groundwater. Hydrologic data are collected regularly from the Burn Site Production Well, CYN-MW1D, 12AUP01 (piezometer), and CYN-MW2S (piezometer). The remainder of this section summarizes the hydrologic conditions at each monitoring well location.

The Burn Site Production Well was drilled in February 1986 to a total depth of 350 feet bgs (Figure 4.2.1-1). A total of 74 feet of clay, silt, and shale units were encountered overlying the bedrock identified as metamorphic schists and fractured granite. Water-bearing bedrock was encountered at a depth of 222 to 350 feet bgs (New Mexico State Engineer's Office Well Record RG-44986 [April 1986]). Following well completion, the water level rose to 68 feet bgs.

A shallow underflow piezometer was installed in November 1996 in SWMU 12A near the SWMU 65D boundary (Figure 4.2.1-1). The NFA proposal for SWMU 12A has been submitted to the New Mexico Environment Department (NMED) for an NFA decision (SNL/NM May 1997). The piezometer was installed in conformance with an understanding between SNL/NM and the NMED/DOE Oversight Bureau (OB) (Dawson August 1996). The subsurface geology of the site is comprised of approximately 55 feet of alluvial sand, silt, and gravel overlying metamorphic phyllite to schist bedrock. The piezometer was completed to a depth of approximately 58 feet bgs and was identified as 12AUP01. Moist soil was encountered in the first 5 feet of alluvium. The remaining 53 feet to bedrock were dry. No groundwater was encountered during drilling. The piezometer was instrumented in February 1997 and has been collecting data since that time. In addition, manual checks for the presence of water have been conducted as a

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Figure 4.2.1-3a SWMU 65A, Small Debris Mound Before Bunker Unearthed.

Figure 4.2.1-3b SWMU 65A, After Discovery of Buried Bunker.

Figure 4.2.1-4a Entrance to SWMU 65A Bunker.

Figure 4.2.1-4b Bunker Interior Showing Burned Soil, Foam, and Wood on the Bunker Floor.

verification procedure. No water has been recorded in the piezometer subsequent to its installation.

A groundwater monitoring well nest was installed in November and December 1997 approximately 3,000 feet west (downgradient) of the LCETS (Figure 4.2.1-1). The groundwater wells were installed in conformance with an understanding between SNL/NM and the NMED (SNL/NM July 1997, SNL/NM September 1997). This well nest is comprised of a shallow underflow piezometer (CYN-MW2S) and a deep groundwater well (CYN-MW1D). The subsurface geology at the nest location is characterized by approximately 25 feet of alluvial sand, silt, and gravel, unconformably overlying the Manzanita Gneiss. The Manzanita Gneiss is fractured. No water was encountered during drilling in the alluvium, and there has been no recorded measurement of water at CYN-MW2S since its installation. Groundwater was first encountered in CYN-MW1D at a depth of 372 feet bgs, and the static level rose to 320 feet bgs. This indicates semiconfined to confined groundwater conditions similar to those encountered in the Burn Site Well (Figure 4.2.1-1).

In summary, the groundwater beneath the LCETS occurs at depths of 222 feet bgs under semiconfined to confined conditions in fractured metamorphic rock. There has been no record to date of shallow groundwater occurring in the alluvium overlying the bedrock.

The Burn Site Spring (Figure 4.2.1-1) is a perennial spring or, more accurately, a seep located approximately 2,200 feet northeast of SWMU 65A. The seep discharges small quantities of water from fractures and/or bedding plane permeability within the carbonate rocks (Goodrich [Month unk] 1993). It is hypothesized that the source of the water is from the seasonal recharge of fractures from the surrounding mountain terrain.

For a detailed discussion regarding the local setting at SWMU 65A, refer to the RFI Work Plan for OU 1333 (SNL/NM September 1995).

4.2.2 Operational History

Historical aerial photographs indicate that construction of the LCETS had begun by October 1967; by 1971 the test site was in full operation and several structures were visible. To protect the surrounding area from accidental fires caused by detonation of explosives or burn testing, a firebreak road was constructed around the site between 1967 and mid-1971 (SNL/NM August 1994).

Interviews with former SNL/NM personnel aided in reconstructing historical operations at SWMU 65 (Table 4.2.2-1, Annex 4-A). SWMU 65 was established between 1967 and 1969 as an explosives test area designed with a 10,000-foot dispersion radius to provide an adequate buffer for open detonations of up to 10,000 pounds of high explosives (HE). The majority of the open-detonation explosives tests were conducted between 1968 and 1975. All open-detonation explosives tests were concluded by the early 1980s. The frequency of testing at SWMU 65 between 1968 and 1980 has been estimated at 15 to 20 tests per year. Based upon information provided in the interviews, open-detonation explosives tests were conducted within the primary (SWMU 65B) and secondary (SWMU 65C) detonation areas.

Table 4.2.2-1
Summary of Tests Conducted at SWMU 65, Lurance Canyon Explosives Test Site

Test Category	Test Type	Test Date	Number of Recorded Tests	Test Materials	Test Location	Reference
General explosives tests	Open-detonation tests	1967 to 1980	260 (20 per year)	Weapons containing HE and DU	Primary and secondary detonation area	65-3 65-10 65-54 65-59
	Ammonium nitrate/fuel rod shipping container test	Between 1967 and 1975	1	Shipping containers for spent fuel rods, ammonium nitrate	Near the LOBP in secondary detonation area	65-3 65-37 65-54
	Penetration tests	Between 1980 and 1985	Unknown	B-61 warhead containing HE and DU	East of camera bunker, west of arroyo in primary detonation area	65-3 65-54 65-63
	Propagation test	Between 1965 and 1979	1	Weapons containing HE	Approximately 1,100 feet SE of Bunker 9830 near SWMU 13	65-61 65-67
Burn pit tests (fuel fire)	Cloudmaker tests	January 1969	3	JP-4 fuel, PVC, TNT, ammonium nitrate, aluminum powder, steel cylinder	Approximately 1,000 feet SE of Bunker 9830 in secondary detonation area	65-32
	Other ammonium nitrate tests	January 1969	2	JP-4 fuel, ammonium nitrate, steel cylinder	SE of Bunker 9830 in secondary detonation area	65-37
	Liquid fuel fire and solid rocket propellant burn tests on pioneer capsules	September 1970	7	JP-4 fuel, TP-H-3062 rocket propellant, Pioneer capsules	SE of Bunker 9830 in secondary detonation area	65-38 65-39
	Plutonium shipping container tests	May to June 1972	5	JP-4 fuel, PVC, polyethylene bottles, Dy-Kem steel-blue layout dye, Celotex insulation, steel containers	Lined fire pit facility in secondary detonation area	65-41
	TC-708 emergency denial device test	February 1973	1	Diesel fuel, PVC, chromel/alumel thermocouples	Approximately 1,000 feet SE of Bunker 9830 in secondary detonation area	65-40

Refer to footnotes at end of table.

Table 4.2.2-1 (Concluded)
Summary of Tests Conducted at SWMU 65, Lurance Canyon Explosives Test Site

Test Category	Test Type	Test Date	Number of Recorded Tests	Test Materials	Test Location	Reference
Miscellaneous Burn tests (nonpetroleum fuel fire)	Wood crib fire tests	September 1988 to September 1989	17	Wood, HE, detonators	Graded area south of SWISH Unit in primary detonation area	65-48 65-73
	Liquid oxygen torch tests	January 1984 to April 1985	19	Propane, oxygen as liquid and gas, aluminum powder, nitrogen gas, graphite, steel rods	Graded area within 30 feet of camera bunker in primary detonation area	65-48 65-73
	Rocket propellant tests	January 1984 to August 1993	10	Rocket propellant, empty weapon casings, aluminum	4 locations in primary detonation area and Bomb Burner and CON-CON trenches	65-48 65-72 65-73
Cone tests	Overburden penetration tests	March 1982 to May 1984	22	C-4 HE, sodium-24 isotope ($t_{1/2}$ = 15 hr), uranium dioxide powder, sand, aqueous foam	CON-CON Unit	65-48 65-49
TABS tests	Torch burn tests on weapons	February 1975 to February 1977	12	PBX 9404 HE, DU, beryllium, aluminum	Location A was 45 feet SE of camera bunker in primary detonation area and in Bomb Burner trench	65-50 65-56 65-57
Slow-heat tests	Detonation of HE with heat tape	February 1982 to August 1986	16	PBX 9501, PBX 9404, PBX 9407, HMX, TATB HE; lead tape; chromel/alumel thermocouples; steel test vessel; plywood and vermiculite packaging	Graded area between camera bunker and CON-CON Unit	65-29 65-30 65-31 65-48

65-3 = Gaither et al. May 1993.
65-10 = Author [Unk] Date [Unk].
65-29 = Luna October 1985.
65-30 = Luna June 1983.
65-31 = Moore and Luna February 1982.
65-32 = Littrel February 1969.
65-37 = Karas June 1993.
65-38 = Foy April 1971.
65-39 = Clark December 1970.
65-40 = Walkington April 1973.
65-41 = Stravasnik September 1972.
65-48 = SNL/NM August 1986.
65-49 = Church March 1982.
65-50 = Kurowski January 1979.
65-54 = Larson and Palmieri August 1994b.
65-56 = Jercinovic et al. November 1994.
65-57 = Larson August 1994.
65-59 = Larson and Palmieri August 1994a.
65-61 = Palmieri November 1994a.
65-63 = Palmieri December 1994b.
65-67 = Palmieri December 1994a.
65-72 = Palmieri December 1994d.
65-73 = Hickox and Abitz December 1994.
C-4 = Composition-4.
CON-CON = Conical Containment.
DU = Depleted uranium.
HE = High explosive(s).
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
hr = Hour(s).
JP-4 = Jet fuel composition 4.
LOBP = Large Open Burn Pool.
PBX = Plastic-bonded high explosive(s).
PVC = Polyvinyl chloride.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.
SWISH = Small Wind-Shielded.
$t_{1/2}$ = Half life.
TABS = Torch Activated Burn System.
TATB = Triaminotrinitrobenzene.
Tetryl = 2,4,6-trinitrophenylmethylnitramine.
TNT = Trinitrotoluene.

In addition to open-detonation explosives tests, fuel-fire burn tests of test units containing explosives were conducted at SWMU 65 from 1969 to 1979 in excavated pits. Portable pans and engineered burn structures completely replaced burn pit tests by 1979. From the mid-1970s, a variety of nonpetroleum fuel fire burn tests were conducted. These tests included slow-heat detonations (1983 to 1986), Torch-Activated Burn System tests (1975 to 1977), rocket propellant burn tests (1984 to 1993), liquid oxygen torch tests (1984 to 1985), and wood crib fire tests (1988 to 1989). Small explosives tests were also conducted in the former Conical Containment (CON-CON) Unit in 1982. Table 4.2.2-2 correlates the SWMU 65 subunits with the explosives/burn testing programs. Annex 4-A contains a summary of all explosives testing at SWMU 65 and shows the locations of these tests.

Available information collected from interviews suggests that SWMU 65A was used as a camera bunker for recording large open-detonation explosives tests and as a storage place for supplies associated with the explosives testing. It is believed that the bunker was last used in a propagation test in which a live bomb was detonated adjacent to the bunker to determine whether this would cause a bomb stored inside the bunker to detonate. Visual observations indicate that there was a fire inside SWMU 65A but no major explosion. The bunker was covered with soil after this test.

4.3 Land Use

Section 4.3 discusses the current and future/proposed land use for SWMU 65A.

4.3.1 Current

SWMU 65A is located within the boundaries of Kirtland Air Force Base (Figure 4.3.1-1) within the active industrial LCBS (SWMU 94).

4.3.2 Future/Proposed

The future/proposed land use for SWMU 65A is recreational (DOE et al. October 1995).

4.4 Investigatory Activities

SWMU 65A has been evaluated in a series of three investigations. After characterization of the bunker, a VCA was performed and then confirmatory samples were collected. Section 4.4 describes these activities.

4.4.1 Summary

SWMU 65A was initially investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s (Investigation #1) in conformance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In 1993 preliminary investigations began that included background information reviews, interviews, field surveys, and scoping sampling (Investigation #2). From 1996

Table 4.2.2-2
Correlation Chart of SWMU 65 Subunits with Explosive/Burn Testing Programs

Subunit Number/Name	Testing Programs	Test Nature of Operational Release	Rationale for Characterization
SWMU 65A Small Debris Mound (soil-covered concrete bunker)	Propagation test (unconfirmed)	Open detonations	Potential release of HE and metals.
SWMU 65B Primary Detonation Area	General explosives tests Open-detonation tests Penetration tests	Open detonations	Potential release of HE, metals, and DU.
	Miscellaneous burn tests Wood crib fire tests Liquid oxygen torch tests Rocket propellant tests	Open burning/ Open detonations	Potential release of HE from wood crib fire tests only.
	Slow-heat tests	Open detonations	Potential release of HE.
	TABS Test Location A	Open burning	Potential release of metals and DU.
SWMU 65C Secondary Detonation Area	General explosives tests Ammonium nitrate/fuel rod Shipping container test	Open detonation/no release	None. No ammonium nitrate residue. Shipping container did not rupture.
	Burn pit tests Cloudmaker tests Other ammonium nitrate tests Liquid fuel fire and solid rocket propellant tests on pioneer capsules Plutonium shipping container tests TC-708 emergency denial device tests	Open burning/open detonations	Potential release of JP-4, diesel fuels, and metals.
SWMU 65D Near-Field Dispersion Area	Miscellaneous burn tests Wood crib fire tests Liquid oxygen torch tests Rocket propellant tests	Open burning/open detonations	Potential release of HE from wood crib fire tests only.
	Cone tests	Detonations/No Release	None. Detonation was contained by CON-CON facility.
	Slow-heat tests	Open detonations	Potential release of HE.
	Dispersion area for general explosives tests	Open detonations	Potential release of HE, metals, and DU.
SWMU 65E Far-Field Dispersion Area	Dispersion area for general explosives tests	Open detonations	Potential release of HE, metals, and DU.

CON-CON = Conical Containment.
DU = Depleted uranium.
HE = High explosive(s).
JP-4 = Jet fuel composition 4.
SWMU = Solid Waste Management Unit.
TABS = Torch-Activated Burn System.

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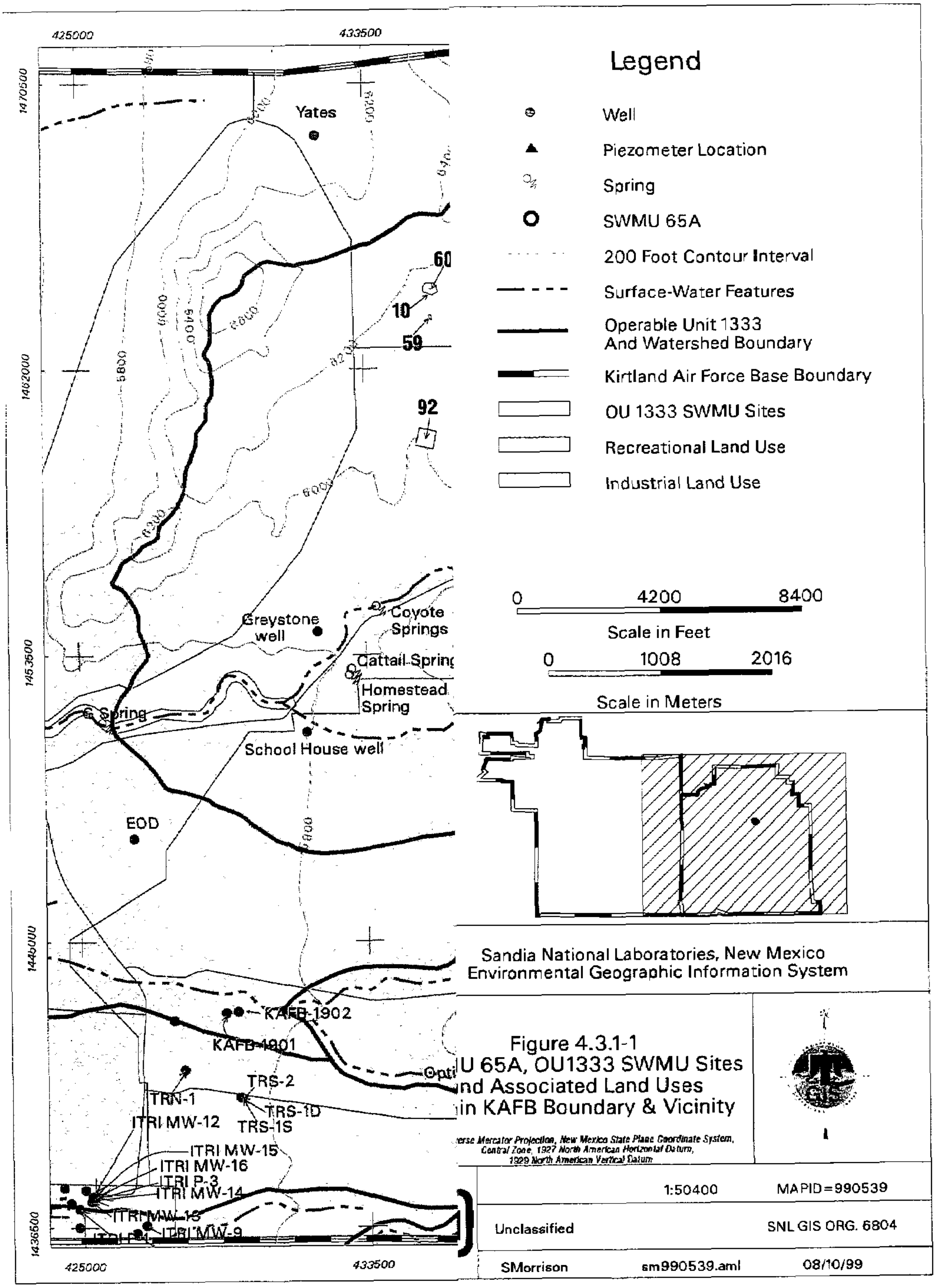

Figure 4.3.1-1
U 65A, OU1333 SWMU Sites
nd Associated Land Uses
in KAFB Boundary & Vicinity

through 1998 additional characterization sampling of the soil outside the bunker and soils and material within the interior of the bunker were conducted (Investigation #3). A VCA conducted in March 1999 included demolition, removal and disposal of the bunker and then confirmatory soil sampling under the former location of the bunker.

4.4.2 Investigation #1—CEARP

4.4.2.1 Nonsampling Data Collection

SWMU 65 was identified as the LCETS during investigations conducted under the CEARP. The CEARP Phase I report documented that both free air and cased explosive charges were detonated at the site, scattering lead and depleted uranium (DU) (DOE September 1987).

4.4.2.2 Sampling Data Collection

No sampling activities were conducted at SWMU 65A as part of the CEARP.

4.4.2.3 Data Gaps

A lack of information prevented calculating of Hazardous Ranking System and Modified Hazard Ranking System migration mode scores. SWMU 65A was not investigated as part of the RCRA Facility Assessment (EPA April 1987).

4.4.2.4 Results and Conclusions

The CERCLA finding under the CEARP was uncertain for Federal Facility Site Discovery and Identification Findings, preliminary assessment, and preliminary site inspection.

4.4.3 Investigation #2—SNL/NM Environmental Restoration Preliminary Investigations

4.4.3.1 Nonsampling Data Collection

This section describes the nonsampling data collected at SWMU 65A.

4.4.3.1.1 Background Review

A background review was conducted to collect available and relevant information regarding SWMU 65A. Background information sources included interviews with SNL/NM staff and contractors familiar with site operational history and existing historical site records and reports. The study was completely documented and has provided traceable references that sustain the integrity of the NFA proposal. Table 4.4.3-1 lists the information sources that were used to assist in evaluating SWMU 65A.

4.4.3.1.2 UXO/HE Survey

In October 1993, Kirtland Air Force Base Explosive Ordnance Disposal personnel conducted a visual survey for the presence of unexploded ordnance (UXO)/HE on the ground surface at SWMU 65. The survey identified one trip flare as live ordnance and one slap flare and one rifle-propelled illuminator round as ordnance debris. In addition, the survey report documented that metal fragments were found in the hills surrounding these sites (Young September 1994).

4.4.3.1.3 Radiological Survey(s)

SWMU 65 is classified as a radioactive material management area (SNL/NM November 1994). On April 30 and May 4, 1993, the SNL/NM Radiation Protection Office personnel conducted surveys of several sections of road in the Coyote Canyon area. The survey consisted of driving on the roads and performing periodic contamination surveys of the vehicle and taking samples of dust from behind the vehicle as it was moving. No contamination was detected on the vehicle using direct scan swipes, nor was airborne radioactivity detected in the dust kicked up by the vehicle (Oldewage May 1993).

During November and December 1993 and January 1994, RUST Geotech Inc. conducted a Phase I surface gamma radiation survey of SWMU 65 in conjunction with SWMUs 12, 13, and 94 (RUST Geotech Inc., December 1994). No radiological anomalies were detected in the immediate vicinity of SWMU 65A .

4.4.3.1.4 Cultural-Resources Survey

A cultural-resources survey of SWMU 65 was conducted as part of the assessment of the Burn Site. Seven cultural resources sites were identified within the boundary of SWMU 65; however, none of these resources were in the immediate vicinity of SWMU 65A (Hoagland and Dello-Russo February 1995).

4.4.3.1.5 Sensitive-Species Survey

A sensitive-species survey was conducted as part of a biological assessment of the LCBS (Biggs May 1991). No sensitive species were found. Although the site is disturbed, it is surrounded by undisturbed riparian woodland and piñon-juniper woodland vegetation. Searches for small cacti (gramma grass and Wright's pincushion cacti) were not conducted during this survey because the elevation of the site and the potential for cold air drainage in this

Table 4.4.3-1
Summary of Background Information Review for SWMU 65A

Information Source	Reference
Technical test reports and project log books	• Littrell February 1969 • Clark December 1970 • Foy April 1971 • Stravasnik September 1972 • Walkington April 1973 • Kurowski January 1979 • Church March 1982 • Moore and Luna February 1982 • Luna June 1983 • SNL/NM August 1986
Engineering drawings	• SNL/NM August 1962 • SNL/NM August 1966
Site inspections (field notes, aerial photograph review, site photographs, radiological, UXO/HE, biological, and cultural resource surveys)	• Gaither [Date unk] • Luna October 1985 • Havlena August 1991 • Gaither October 1992 • Oldewage May 1993 • Karas June 1993 • Oldewage December 1993a • Oldewage December 1993b • Oldewage February 1994 • SNL/NM August 1994 • Young September 1994 • Freshour March 1998 • Freshour May 1998
Employee interviews, 19 interviews with 17 facility personnel (current and retired)	• Martz September 1985 • Martz November 1985 • Gaither et al. May 1993 • Young et al. February 1994 • Brouillard June 1994 • Larson August 1994 • Larson and Palmieri August 1994a • Larson and Palmieri August 1994b • Larson and Palmieri August 1994c • Larson and Palmieri October 1994 • Palmieri and Larson October 1994 • Jercinovic et al. November 1994 • Palmieri November 1994a • Palmieri November 1994b • Hickox and Abitz December 1994 • Palmieri December 1994a • Palmieri December 1994b • Palmieri December 1994c • Palmieri December 1994e

HE = High explosive(s).
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
UXO = Unexploded ordnance.

upper reach of the Lurance Canyon render the presence of these species unlikely (IT February 1995).

4.4.3.1.6 Geophysical Survey(s)

In 1994 surface and borehole geophysical investigations were conducted at two locations in the OU 1333 area in order to determine the depth of bedrock. Test Location 1 was on the eastern edge of SWMU 65E. Test Location 2 was farther downgradient in the Lurance Canyon near the Sol se Mete Canyon. The seismic results from Test Location 1 suggested that alluvial thickness was between 60 and 80 feet (Bay Geophysical Associates, Inc., October 1994). The thickness of the alluvium in this area is known to range from between 58 feet in the boring for 12AUP01 and 74 feet at the Burn Site Well location. No surface geophysical surveys were performed at SWMU 65A.

4.4.3.2 Sampling Data Collection

In July 1995 SWMU 65A was investigated as part of a sitewide scoping sampling program. The purpose of this effort was to obtain preliminary analytical data to support the Environmental Restoration (ER) Project site ranking and prioritization. Three soil samples were collected from one soil boring located on the Small Debris Mound (65A). A surface soil sample was collected (at 0 to 6 inches) and then additional soil aliquots were collected at depths of 1.5 and 2.5 feet (Figure 4.4.3-1). The SNL/NM ER Chemistry Laboratory analyzed these three environmental samples for RCRA metals (plus beryllium) using modified U.S. Environmental Protection Agency (EPA) Method 6010 (EPA, November 1986) and for HE using high-performance liquid chromatography.

4.4.3.3 Data Gaps

Information gathered from process knowledge, from a review of historical site files, and from personal interviews aided in identifying the most likely COCs at SWMU 65A (HE, metals, DU) and in selecting the types of analyses to be performed on soil samples. No contamination was noted in this scoping level data; however, detection limits were higher than many of the established background/risk values. None of the samples were assessed for radiological contamination. The preliminary scoping data are not adequate to support a risk screening assessment. Subsequent investigations would determine that the small debris mound was actually a small bunker that had been covered with soil.

4.4.3.4 Results and Conclusions

Only barium and lead were detected in the soil samples. The concentrations of both metals were not greater than their established background concentrations. The method detection limits (MDLs) for all other metals from the XRF were generally greater than the established background values for metals. No HE compounds were detected in the soil samples at MDLs ranging from between 150 and 750 micrograms (μg)/kilogram (kg). The soil samples were not evaluated for radiological contamination. Additional sampling would be necessary to determine whether any contamination was associated with SWMU 65A.

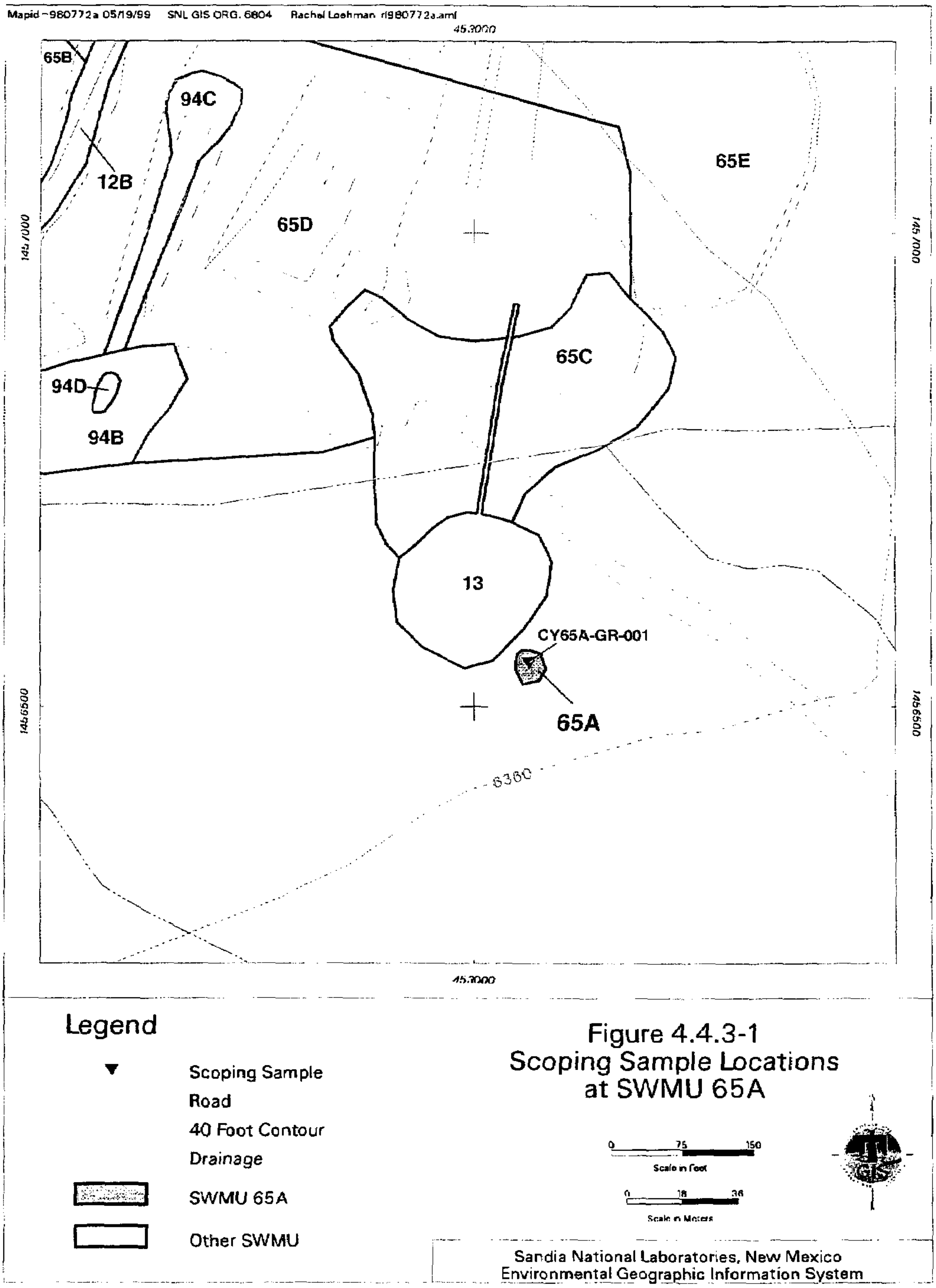

Figure 4.4.3-1
Scoping Sample Locations
at SWMU 65A

4.4.4 Investigation #3—SNL/NM ER Project Characterization Sampling

4.4.4.1 Nonsampling Data Collection

No nonsampling data collection activities were associated with Investigation #3 of SWMU 65A.

4.4.4.2 Sampling Data Collection

This section discusses the background sampling activities that were used to establish the naturally occurring concentrations of inorganics in the surface soil within the Canyons Test Area, and the characterization sampling performed to evaluate the presence of contamination in surface soil outside the bunker as well as soil and material present in the interior of the bunker.

4.4.4.2.1 Site-Specific Background Sampling

SNL/NM conducted background soil and arroyo sediment sampling at the LCETS in June 1996 to establish background concentrations and activities for metals and radionuclides within the Canyons Test Area. The background sampling activities were performed in accordance with the rationale and procedures described in the OU 1333 RFI Work Plan (SNL/NM September 1995), as reviewed by the NMED. In addition to the analyses specified in the OU 1333 RFI Work Plan, SNL/NM also analyzed the samples for isotopic thorium, uranium, and strontium and for gross alpha/gross beta activity. The purpose of the additional analyses was to assess the viability of using gross alpha/gross beta analyses as a low-cost screening tool for future environmental assessment activities by comparing results to more accurate isotopic analysis results. Based upon the Request for Supplemental Information (RSI) (Dinwiddie August 1997, SNL/NM December 1997), additional background soil samples were collected in June 1998 and were analyzed for gross alpha/gross beta. SNL/NM chain-of-custody and sample documentation procedures were followed for all samples collected. Figure 4.4.4-1 shows the background soil and arroyo sediment sample locations associated with SWMU 65.

In June 1996 surface (at 0 to 0.5 foot bgs) and near-surface (at 0.5 to 1.0 foot bgs) background soil and arroyo sediment samples were collected outside the boundary of SWMU 65. Five background soil sample locations and six background arroyo sediment sample locations were specified in the OU 1333 Work Plan. In June 1998 additional soil samples (from 0 to 0.5 foot bgs) were collected at 15 locations outside the boundary of SWMU 65 for analysis for gross alpha/gross beta. The NMED approved these 15 background soil sample locations. Quality assurance (QA)/quality control (QC) samples that were collected include one duplicate soil sample and one duplicate arroyo sediment sample.

The background soil and arroyo sediment samples collected in June 1996 were analyzed off site for RCRA metals plus beryllium, isotopic thorium, uranium, and strontium, and gross alpha and gross beta. The samples collected in June 1996 were also analyzed on site for radionuclides using gamma spectroscopy. Lockheed Analytical Services of Las Vegas, Nevada, analyzed the samples for RCRA metals plus beryllium using EPA Methods 6010/7000 (EPA November 1986); for isotopic thorium, uranium, and strontium using alpha spectroscopy and proportional gas counter; and for gross alpha/gross beta using EPA Method 900.0 (EPA November 1986). SNL/NM Department 7713 (Radiation Protection Sample Diagnostics Laboratory [RPSD] Laboratory) analyzed the samples on site for radionuclides using gamma

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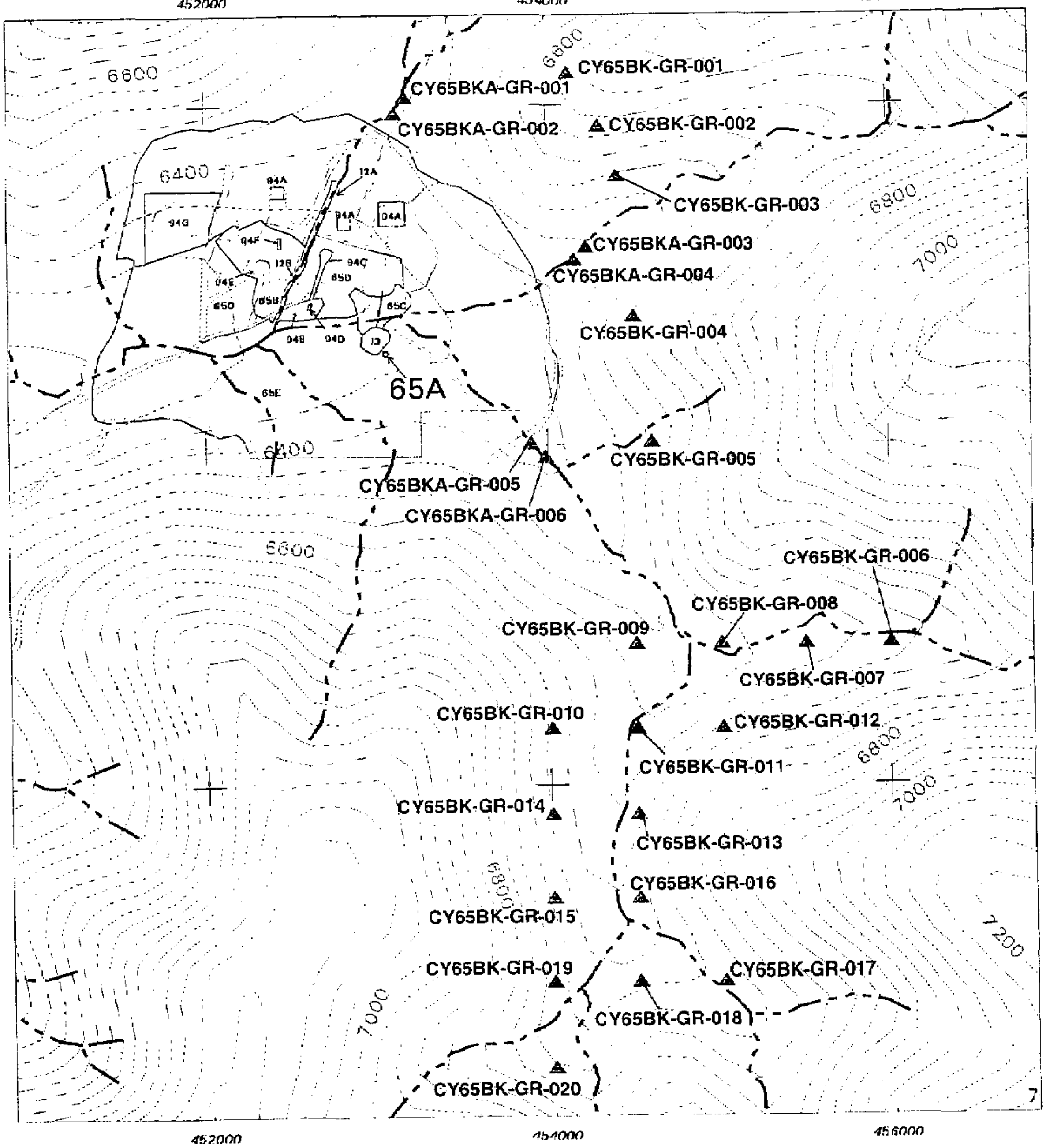

Legend

- ▲ Background Sample Location
- Road
- 40 Foot Contour
- Surface Drainage
- SWMU 65A
- Other SWMUs

**Figure 4.4.4-1
Background Sample
Locations at SWMU 65A**

0 500 1000
Scale in Feet

0 120 240
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

spectroscopy. The background soil samples collected in June 1998 were analyzed off site for gross alpha/gross beta. Core Laboratories, Inc., of Casper, Wyoming, analyzed these samples for gross alpha/gross beta using EPA Method 900.0 (EPA November 1986).

Analytical results for the metals analyses performed on the background soil and arroyo sediment samples that had been collected in June 1996 were included in the formulation of Canyons Area background metals concentrations developed in response to the NMED's RSI to SNL/NM and Kirtland Air Force Base for background concentrations of COCs (Zamorski December 1997). Analytical results for the gross alpha/gross beta analyses performed on the background soil samples that had been collected in June 1998 were included in formulating preliminary Canyons Area background gross alpha/gross beta activities developed by the SNL/NM ER Program (Tharp July 1998).

4.4.4.2.2 Characterization Sampling

SNL/NM conducted characterization sampling in May 1996 and March and May 1998 to determine whether potential COCs were present at levels exceeding background limits at the site and/or at levels sufficient to pose a risk to human health or the environment. In anticipation of a VCA to remove the bunker, additional waste characterization samples were collected inside the bunker in October 1998. Prior to conducting sampling activities at SWMU 65A, it was believed that the site was a small soil/debris mound comprised of the remnants of a concrete bunker that had been destroyed in a weapons test. However, during the initial sampling activities conducted in May 1996 the bunker was found to be intact. As a result, additional sampling was conducted in March 1998 to investigate the interior of the bunker. All sampling activities were performed in accordance with the rationale and procedures described in the OU1333 RFI Work Plan (SNL/NM September 1995) and the Field Implementation Plan (SNL/NM March 1998). SNL/NM chain-of-custody and sample documentation procedures were followed for all samples collected.

In May 1996 and May 1998 soil samples were collected from six locations outside the bunker from within three trenches cut along the closed sides of the bunker. Figure 4.4.4-2 shows these characterization sample locations outside the bunker at SWMU 65A. Figures 4.4.4-3a/b are photographs of the sample trenches. No contaminated soil or debris was noted in these trenches. The only material present in the soil surrounding the bunker included several pieces of concrete and rock. All soil samples collected in May 1996 were analyzed on site. SNL/NM Department 6684 (ER Chemistry Laboratory) analyzed the samples for RCRA metals plus beryllium using EPA Method 6010/7000 (EPA November 1986) and for HE using micellar electrokinetic chromatograph. In addition, one sample was split for analysis at an off-site laboratory. A QA/QC equipment rinsate sample was also sent to the off-site laboratory. Lockheed Analytical Services of Las Vegas, Nevada, analyzed the samples for RCRA metals plus beryllium using EPA Methods 6010/7000 (EPA November 1986) and for HE using EPA Method 8330 (EPA November 1986). SNL/NM Department 7713 (RPSD laboratory) analyzed one sample on site for radionuclides using gamma spectroscopy to permit the off-site transport of samples to Lockheed.

In March 1998 soil samples were collected from immediately inside the bunker door and at approximately the midpoint of the bunker. The bunker had a foam/concrete floor; however, there was no door on the bunker and several feet of soil overlay the floor, which presumably

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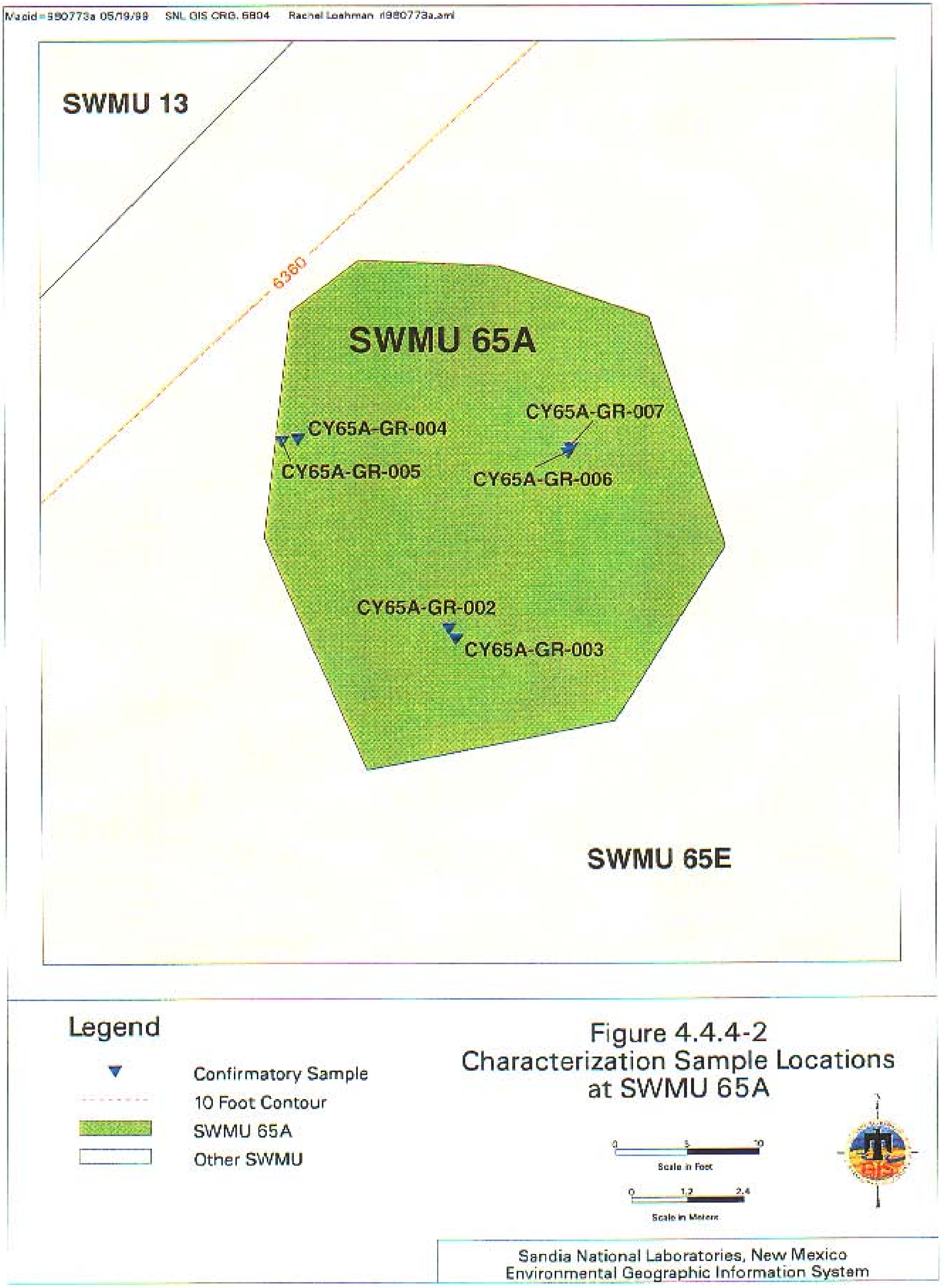

Figure 4.4.4-2
Characterization Sample Locations
at SWMU 65A

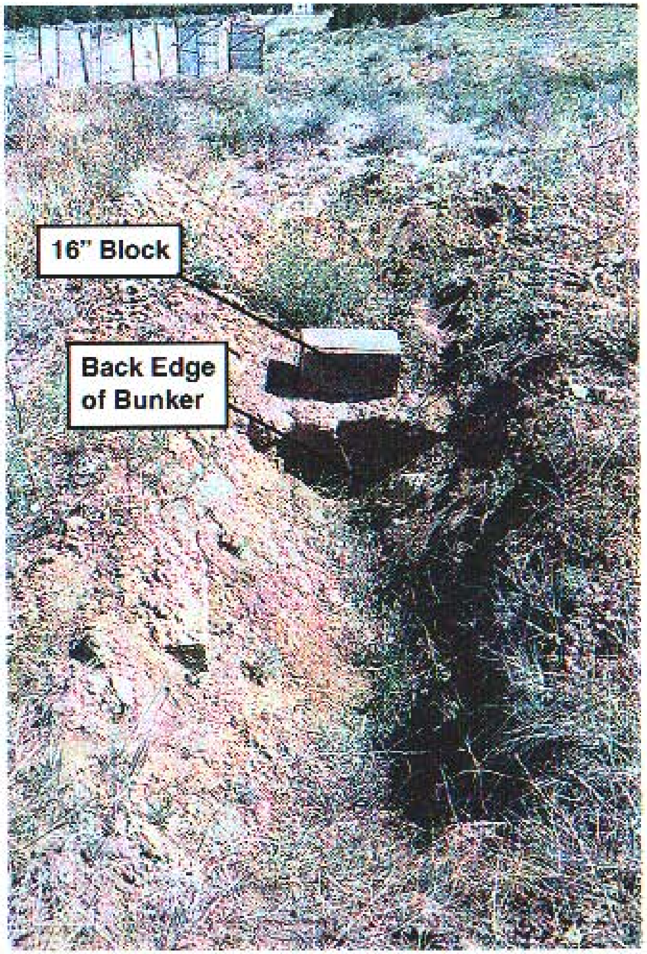

Figure 4.4.4-3a Trench No. 1, SWMU 65A for Characterization Sampling. Sixteen-inch Block for Scale. View is to the Northeast.

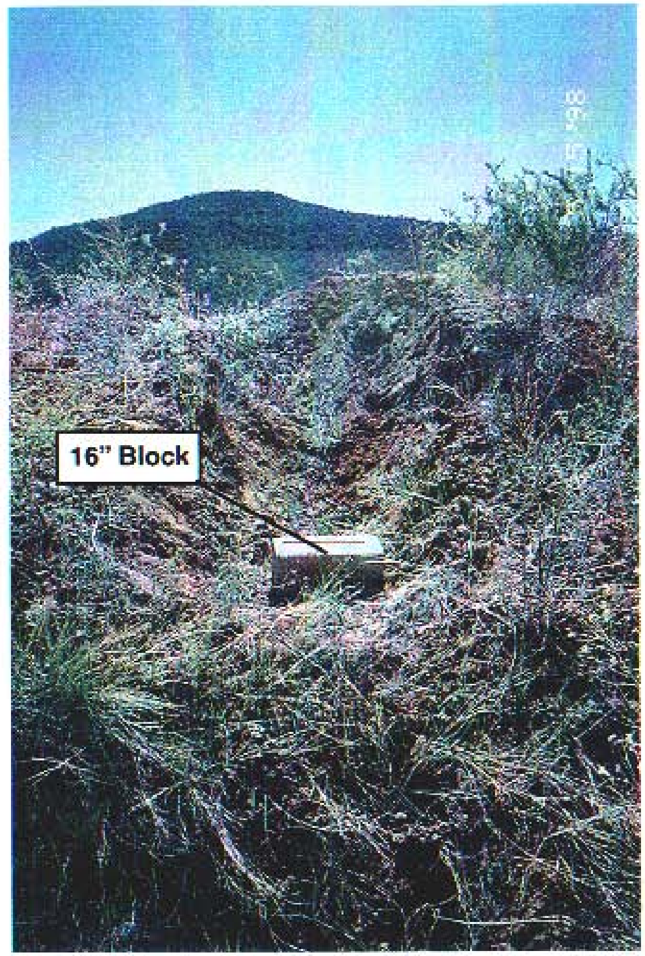

Figure 4.4.4-3b Trench No.2, SWMU 65A for Characterization Sampling. Sixteen-inch Block for Scale. View is to the East.

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Table 4.4.4-1
Summary of SWMU 65A Characterization Soil Sampling Metals Analytical Results, May 1996 and May 1998

Sample Attributes			Metals (EPA Method 6010/7000[a]) (mg/kg)								
Record Number[b]	ER Sample ID (Figure 4.4.4-2[c])	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
Outside Bunker (ER Chemistry Lab)											
5304	CY65A-GR-002-0-SS	0.0	ND (26)	240	ND (0.11)	ND (2.1)	12 J (19)	ND (3.4)	ND (0.06)	ND (50)	ND (1.7)
5304	CY65A-GR-003-1-S	1.0	ND (26)	**250**	ND (0.11)	ND (2.1)	12 J (19)	3.4 J (13)	ND (0.06)	ND (50)	ND (1.7)
5303	CY65A-GR-003-1-S (off-site laboratory)	1.0	5.0	180	**0.78 J (1.0)**	0.46 J (1.0)	14.9	11.4	ND (0.10)	0.76 J (1.0)	ND (0.20)
5304	CY65A-GR-004-1-S	1.0	ND (26)	220	ND (0.11)	ND (2.1)	11 J (19)	ND (3.4)	ND (0.06)	ND (50)	ND (1.7)
5304	CY65A-GR-005-0-SS	0.0	ND (26)	230	ND (0.11)	ND (2.1)	12 J (19)	ND (3.4)	ND (0.06)	ND (50)	ND (1.7)
5304	CY65A-GR-006-0-SS	0.0	ND (26)	**250**	ND (0.11)	ND (2.1)	14 J (19)	ND (3.4)	ND (0.06)	ND (50)	ND (1.7)
5304	CY65A-GR-007-0-SS	0.0	ND (26)	220	ND (0.11)	ND (2.1)	14 J (19)	ND (3.4)	ND (0.06)	ND (50)	ND (1.7)
Inside Bunker (Off-Site Laboratory)											
600051	CY65A-BNK-01-0.0	0.0	ND (0.033079)	137	0.509	**3.17**	9.00	8.82	0.0254 J (0.10)	ND (0.054874)	**1.74**
600051	CY65A-BNK-01-0.0-MS	0.0	ND (0.033079)	149	0.505	**2.27**	7.09	5.37	0.0327 J (0.10)	ND (0.054874)	**1.84**
600051	CY65A-BNK-02-0.0	0.0	ND (0.033079)	190	0.647	**2.56**	10.1	8.96	0.0398 J	ND (0.054874)	**27.4**
600051	CY65A-BNK-03-3.0	3.0	**10.7**	193	0.733	**2.60**	14.8	6.76	0.0239 J (0.10)	**53.8 J**	ND (0.002914)
600051	CY65A-BNK-03-3.0-DU	3.0	**15.7**	174	0.737	**2.99**	12.0	7.39	0.0285 J (0.10)	ND (0.054874)	**0.516 J (1)**
Background Soil Concentrations, Canyons Test Area[d]			9.8	246	0.75	0.64	18.8	18.9	0.055	2.7	<0.5
Quality Assurance/Quality Control Sample (mg/L)											
5303	CY65A-GR-008-EB (off-site laboratory)	NA	ND (0.0030)	ND (0.0010)	ND (0.0010)	ND (0.0030)	ND (0.0040)	ND (0.0020)	ND (0.00020)	ND (0.0040)	ND (0.0010)
600051	CY65A-BNK-EB (off-site laboratory)	NA	ND (0.033079)	0.00344	ND (0.001811)	ND (0.002453)	ND (0.003826)	0.0278 J (0.05)	ND (0.000047)	0.0793 J (0.1)	ND (0.002914)

Note: **Bold** indicates values that exceed background soil concentrations.

[a]EPA November 1986.
[b]Analysis request/chain of custody.
[c]Bunker sampling locations not shown in Figure 4.4.4-2.
[d]From SNL/NM December 1997.

B = Analyte detected in associated blank.
BNK = Bunker.
CY = Canyon.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Analytical result was qualified as an estimation during validation.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit for on-site laboratory analyses or the reporting detection limit for off-site laboratory analyses, shown in parenthesis.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
MS = Matrix spike, reported values represent analytical results prior to the addition of the matrix spike.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
S = Subsurface soil sample.
SNL/NM = Sandia National Laboratories/New Mexico.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.

Table 4.4.4-2
Summary of SWMU 65A Debris Sampling TCLP Metals Analytical Results, March 1998
(Off-Site Laboratory)

Sample Attributes			Metals (EPA Method 1311/6010/7000[a]) (mg/L)								
Record Number[b]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600051	CY65A-BNK-04-C (Foam)	0.0	0.0548	0.604	ND (0.001811)	0.00314 J (0.01)	0.0418 J	ND (0.024842)	ND (0.000047)	ND (0.054874)	ND (0.002914)
600051	CY65A-BNK-04-C-DU (Foam)	0.0	0.0394 J (0.05)	0.473 J (0.5)	ND (0.001811)	ND (0.002453)	0.0184 J	ND (0.024842)	ND (0.000047)	0.0854 J (0.1)	ND (0.002914)
600051	CY65A-BNK-05-W (Foam)	0.0	ND (0.033079)	0.575	ND (0.001811)	ND (0.002453)	0.0799 J	ND (0.024842)	ND (0.000047)	ND (0.054874)	ND (0.002914)
Maximum Concentration of Contaminants for the Toxicity Characteristic (mg/L)[c]			5.0	100.0	--	1.0	5.0	5.0	0.2	1.0	5.0

[a]EPA November 1986.
[b]Analysis request/chain of custody.
[c]EPA, 40 CFR Part 261.24.

BNK = Bunker.
C = Ceiling.
CFR = Code of Federal Regulations.
CY = Canyon.
DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Analytical result was qualified as an estimation during validation.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.
mg/L = Milligram(s) per liter.
ND ( ) = Not detected above the MDL, shown in parenthesis.
SWMU = Solid Waste Management Unit.
TCLP = Toxicity Characteristic Leaching Procedure.
W = Wall.
-- = No maximum concentration established for beryllium.

Table 4.4.4-3
Summary of SWMU 65A, Bunker Floor Soil, TCLP Metals Analytical Results, October 1998
(ER Chemistry Lab)

Sample Attributes			Metals (EPA Method 1311/6010/7000[a]) (mg/L)								
Record Number[b]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
601126	CY65A-BNK-001	0.0–0.5	0.0056 J (0.0034)	2.4	ND (0.00028)	0.0061	0.018 JB (0.045)	0.0086	ND (0.00023)	0.0092 J	ND (0.00023)
601126	CY65A-BNK-002-DU	0.0–0.5	ND (0.0034)	2.4 B	ND (0.00028)	0.0078	0.02 JB (0.045)	0.0056 J (0.0068)	ND (0.00023)	0.0084 J	ND (0.00023)
Maximum Concentration of Contaminants for the Toxicity Characteristic (mg/L)[c]			5.0	100.0	--	1.0	5.0	5.0	0.2	1.0	5.0

[a]EPA November 1986.
[b]Analysis request/chain of custody.
[c]From EPA, 40 CFR Part 261.24.

B = Contamination found in blank
BNK = Bunker.
CFR = Code of Federal Regulations.
CY = Canyon.
DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.
J = Analytical result was qualified as an estimation during validation.
mg/L = Milligram(s) per liter.
ND ( ) = Not detected above the MDL, shown in parenthesis.
SWMU = Solid Waste Management Unit.
TCLP = Toxicity Characteristic Leaching Procedure.
-- = No maximum concentration established for beryllium.

Table 4.4.4-4
Summary of SWMU 65A Characterization Soil Sampling HE Analytical Results, May 1996 and May 1998
(Off-Site Laboratory)

Sample Attributes			Explosives, Methods (EPA Method 8330[a]) (μg/kg)						
Record Number[b]	ER Sample ID (Figure 4.4.4-2)[c]	Sample Depth (ft)	2,4,6-trinitrotoluene	2,4-dinitrotoluene	2,6-dinitrotoluene	2 amino 4,6-dinitrotoluene	4 amino 2,6-dinitrotoluene	o-nitrotoluene (2)	m-nitrotoluene (3)
Outside Bunker (ER Chemistry Lab)									
5303	CY65A-GR-003-1-S (off-site laboratory)	1.0	ND (270)	ND (280)	ND (270)	ND (270)	ND (270)	ND (270)	ND (270)
600273	CY-65A-01-TRENCH1-0.0	0.0–0.5	ND (300)	ND (260)	ND (300)	ND (130)	ND (110)	ND (160)	ND (160)
600273	CY-65A-02-TRENCH1-1.0	0.0–0.5	ND (310)	ND (270)	ND (310)	ND (140)	ND (120)	ND (160)	ND (160)
600273	CY-65A-03-TRENCH2-1.0	0.0–0.5	ND (310)	ND (260)	ND (310)	ND (140)	ND (110)	ND (160)	ND (160)
600273	CY-65A-04-TRENCH2-0.0	0.0–0.5	ND (310)	ND (270)	ND (310)	ND (140)	ND (120)	ND (160)	ND (160)
600273	CY-65A-05-TRENCH3-0.0	0.0–0.5	ND (320)	ND (270)	ND (320)	ND (140)	ND (120)	ND (160)	ND (160)
600273	CY-65A-06-TRENCH3-0.0	0.0–0.5	ND (320)	ND (270)	ND (320)	ND (140)	ND (120)	ND (160)	ND (160)
Inside Bunker (Off-site Laboratory)									
600051	CY65A-BNK-01-0.0	0.0–0.5	ND (19)	ND (17)	ND (17)	ND (17)	ND (79)	ND (41)	ND (30)
600051	CY65A-BNK-02-0.0	0.0–0.5	ND (19)	ND (17)	ND (17)	ND (17)	ND (79)	ND (41)	ND (30)
600051	CY65A-BNK-03-3.0	3.0	ND (19)	ND (17)	ND (17)	ND (17)	ND (79)	ND (0.16)	ND (0.39)
600051	CY65A-BNK-03-3.0-DU	3.0	ND (19)	ND (17)	ND (17)	ND (17)	ND (79)	ND (41)	ND (30)
Quality Assurance/Quality Control Sample (μg/L)									
5303	CY65A-GR-008-EB (off-site laboratory)	NA	ND (0.26)	ND (0.26)	ND (0.25)	ND (0.26)	ND (0.26)	ND (0.25)	ND (0.25)
600051	CY65A-BNK-EB	NA	ND (0.11)	ND (0.10)	ND (0.13)	ND (0.14)	ND (0.16)	ND (0.16)	ND (0.39)

Refer to footnotes at end of table.

Table 4.4.4-4 (Concluded)
Summary of SWMU 65A Characterization Soil Sampling HE Analytical Results, May 1996 and May 1998 (Off-Site Laboratory)

Sample Attributes			Explosives, Methods (EPA Method 8330)[a] (µg/kg)						
Record Number[b]	ER Sample ID (Figure 4.4.4-2)[c]	Sample Depth (ft)	p-nitrotoluene (4)	Nitrobenzene	1,3-dinitrobenzene	1,3,5-trinitrobenzene	RDX	Tetryl	HMX
Outside Bunker (ER Chemistry Lab)									
5303	CY65A-GR-003-1-S (off-site laboratory)	1.0	ND (270)	ND (280)	ND (270)	ND (270)	ND (1100)	ND (710)	ND (2400)
600273	CY-65A-01-TRENCH1-0.0	0.0–0.5	ND (130)	ND (180)	ND (78)	ND (110)	ND (190)	ND (360)	ND (130)
600273	CY-65A-02-TRENCH1-1.0	0.0–0.5	ND (140)	ND (190)	ND (81)	ND (120)	ND (200)	ND (370)	ND (140)
600273	CY-65A-03-TRENCH2-1.0	0.0–0.5	ND (140)	ND (180)	ND (80)	ND (110)	ND (200)	ND (370)	ND (140)
600273	CY-65A-04-TRENCH2-0.0	0.0–0.5	ND (140)	ND (190)	ND (81)	ND (120)	ND (200)	ND (370)	ND (140)
600273	CY-65A-05-TRENCH3-0.0	0.0–0.5	ND (140)	ND (190)	ND (82)	ND (120)	ND (200)	ND (380)	ND (140)
600273	CY-65A-06-TRENCH3-0.0	0.0–0.5	ND (140)	ND (190)	ND (83)	ND (120)	ND (200)	ND (380)	ND (140)
Inside Bunker (Off-Site Laboratory)									
600051	CY65A-BNK-01-0.0	0.0	ND (31)	ND (9.0)	ND (16)	ND (32)	ND (31)	ND (94)	ND (24)
600051	CY65A-BNK-02-0.0	0.0	ND (31)	ND (0.12)	ND (16)	ND (32)	ND (0.12)	ND (94)	ND (24)
600051	CY65A-BNK-03-3.0	3.0	ND (31)	ND (9.0)	ND (16)	ND (32)	ND (31)	ND (94)	ND (24)
600051	CY65A-BNK-03-3.0-DU	3.0	ND (31)	ND (9.0)	ND (16)	ND (32)	ND (31)	ND (94)	ND (24)
Quality Assurance/Quality Control Sample (µg/L)									
5303	CY65A-GR-008-EB (off-site laboratory)	NA	ND (0.25)	ND (0.50)	ND (0.30)	ND (0.45)	ND (0.85)	ND (1.0)	ND (1.0)
600051	CY65A-BNK-EB (off-site laboratory)	NA	ND (0.19)	ND (0.12)	ND (0.11)	ND (0.32)	ND (0.12)	ND (0.18)	ND (0.095)

Note: **Bold** indicates a positive detection of an HE analyte.

[a]EPA November 1986.

[b]Analysis request/chain of custody.

[c]Bunker and trench sampling locations not shown on Figure 4.4.4-2.

BNK = Bunker.
CY = Canyon.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
HE = High explosives.
ID = Identification.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
SWMU = Solid Waste Management Unit.

Table 4.4.4-5
Summary of SWMU 65A Debris Sampling TCLP HE Analytical Results, March 1998
(Off-Site Laboratory)

Sample Attributes			Explosives, Methods (EPA 1311/8330[a]) (µg/L)						
Record Number[b]	ER Sample ID	Sample Depth (ft)	2,4,6-trinitrotoluene	2,4-dinitrotoluene	2,6-dinitrotoluene	2 amino 4,6-dinitrotoluene	4 amino 2,6-dinitrotoluene	o-Nitrotoluene (2)	m-nitrotoluene (3)
600051	CY65A-BNK-04-C (foam)	0.0	ND (0.11)	ND (0.10)	ND (0.13)	ND (0.14)	ND (0.16)	ND (0.16)	ND (0.39)
600051	CY65A-BNK-04-C-DU (foam)	0.0	ND (0.11)	ND (0.10)	ND (0.13)	ND (0.14)	ND (0.16)	ND (0.16)	ND (0.39)
600051	CY65A-BNK-05-W (foam)	0.0	ND (0.11)	ND (0.10)	ND (0.13)	ND (0.14)	ND (0.16)	ND (0.16)	ND (0.39)
			p-nitrotoluene (4)	Nitrobenzene	1,3-dinitrobenzene	1,3,5-trinitrobenzene	RDX	Tetryl	HMX
600051	CY65A-BNK-04-C (foam)	0.0	ND (0.19)	ND (0.12)	ND (0.11)	ND (0.32)	ND (0.12)	ND (0.18)	**82**
600051	CY65A-BNK-04-C-DU (foam)	0.0	ND (0.19)	ND (0.12)	ND (0.11)	ND (0.32)	ND (0.12)	ND (0.18)	**210**
600051	CY65A-BNK-05-W (foam)	0.0	ND (0.19)	ND (0.12)	ND (0.11)	ND (0.32)	ND (0.12)	ND (0.18)	**130**

Note: **Bold** indicates a positive detection of an HE analyte.

[a]EPA November 1986.
[b]Analysis request/chain of custody

BNK = Bunker.
C = Ceiling.
CY = Canyon.
DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = *Foot (feet).*
HE = High explosives.
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
ID = Identification.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.
µg/L = Microgram(s) per liter.
ND ( ) = Not detected above the MDL, shown in parenthesis.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.
TCLP = *Toxicity Characteristic Leaching Procedure.*
Tetryl = 2,4,6-trinitrophenylmethylnitramine.
W = Wall.

Table 4.4.4-6
Summary of SWMU 65A Characterization Soil and Debris Sampling Gamma Spectroscopy Analytical Results, May 1996 and March 1998 (On-Site Laboratory)

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
Record Number[a]	ER Sample ID (Figure 4.4.4-2[b])	Sample Depth (ft)	Uranium-238 Results	Uranium-238 Error[c]	Thorium-232 Results	Thorium-232 Error[c]	Uranium-235 Results	Uranium-235 Error[c]	Cesium-137 Results	Cesium-137 Error[c]
Outside Bunker										
05302	CY65A-GR-003-1-S	1.0	ND (1.56E+00)	--	8.65E-01	4.13E-01	ND (2.18E-01)	--	ND (4.24E-02)	--
Inside Bunker										
600050	CY65A-BNK-01-0.0	0.0	ND (1.44E+00)	--	4.42E-01	2.40E-01	ND (2.03E-01)	--	6.20E-02	4.95E-02
600050	CY65A-BNK-04-C (foam)	NA	ND (2.18E+01)	--	ND (3.73E+00)	--	ND (3.09E+00)	--	ND (6.62E-01)	--
Background Soil Concentrations, Upper Canyons[d]			2.31	NA	1.03	NA	0.16	NA	0.515	NA

[a] Analysis request/chain of custody.
[b] Bunker sampling locations not shown on Figure 4.4.4-2.
[c] Two standard deviations above the mean detected activity.
[d] From Dinwiddie September 1997.

BNK = Bunker.
C = Ceiling.
CY = Canyons.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
ND = Not detected above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.
-- = Error not calculated for nondetectable results.

Table 4.4.4-7
Summary of SWMU 65A, Waste Characterization Sampling, Gamma Spectroscopy Analytical Results, October 1998 (RPSD)

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
			Uranium-238		Thorium-232		Uranium-235		Cesium-137	
Record Number[a]	ER Sample ID	Sample Depth (ft)	Results	Error[b]	Results	Error[b]	Results	Error[b]	Results	Error[b]
Soil on Bunker Floor										
601127	CY65A-BNK-003	0.0–0.5	ND (0.693)	--	0.821	+/- 0.412	**0.209**	+/-0.181	0.171	+/-0.152
55 Gallon Drum of Foam										
830363	Drum CY65A	NA	ND (1.15)	--	ND (2.02)		ND (2.63)		ND (0.270)	
Background Soil Concentrations, Upper Canyons[c]			2.31	NA	1.03	NA	0.16	NA	0.515	NA

Note: **Bold** indicates values that exceed background soil concentrations.
[a]Analysis request/chain of custody
[b]Two standard deviations above the mean detected activity.
[c]From Dinwiddie September 1997.
BNK = Bunker.
CY = Canyons.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
RPSD = Radiation Protection Sample Diagnostics.
SWMU = Solid Waste Management Unit.
-- = Error not calculated for nondetectable results.

Table 4.4.4-8
Summary of SWMU 65A Characterization Soil and Debris Sampling Gross Alpha and Gross Beta Analytical Results, March 1998 (Off-Site Laboratory)

Sample Attributes			Activity (pCi/g)			
			Gross Alpha		Gross Beta	
Record Number[a]	ER Sample ID	Sample Depth (ft)	Results	Error[b]	Results	Error[b]
Inside Bunker						
600053	CY65A-BNK-01-0.0	0.0	3.44	1.15	30.2	2.16
600053	CY65A-BNK-02-0.0	0.0	4.75	1.22	23.4	2.05
600053	CY65A-BNK-03-3.0	3.0	4.18	1.19	18.0	1.96
600053	CY65A-BNK-03-3.0-DU	3.0	4.50	1.21	21.2	2.01
600053	CY65A-BNK-04-C (foam)	NA	0.970 U	1.020	15.8	1.92
600053	CY65A-BNK-04-C-DU (foam)	NA	2.45 J	1.10	9.83	1.81
600053	CY65A-BNK-05-W (foam)	NA	1.12 U	1.03	3.28	1.69
Background Soil Concentrations, Canyon[c]			18.3	NA	52.7	NA
Quality Assurance/Quality Control Sample (pCi/mL)						
600053	CY65A-BNK-EB	NA	0.230	0.210	-1.55	0.430

[a]Analysis request/chain of custody.
[b]Two standard deviations above the mean detected activity.
[c]From Tharp July 1998.

BNK = Bunker.
C = Ceiling.
CY = Canyons.
DU = Duplicate sample.
EB = Equipment blank.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Analytical result was qualified as an estimation during validation.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
pCi/mL = Picocurie(s) per milliliter.
SWMU = Solid Waste Management Unit.
U = Analytical result was qualified as not detected during data validation.
W = Wall.

Table 4.4.4-9
Summary of SWMU 65A Bunker Soil and Debris Sampling
Nitrate Analytical Results, March 1998
(On-Site Laboratory)

Sample Attributes				Nitrate (EPA Method Nitrate-Capillary Electrophoresis[a]) (mg/kg)
Record Number[b]	ER Sample ID	Sample Depth (ft)	Sample Type	Nitrate (as N)
600049	CY65A-BNK-01-0.0	0.0	Soil	9.2
600049	CY65A-BNK-02-0.0	0.0	Soil	23
600049	CY65A-BNK-03-3.0	3.0	Soil	32
600049	CY65A-BNK-03-3.0-DU	3.0	Soil	46
600049	CY65A-BNK-04-C	NA	Foam	17
600049	CY65A-BNK-04-C-DU	NA	Foam	43
600049	CY65A-BNK-05-W	NA	Foam	24
Quality Assurance/Quality Control Samples (all in mg/L)				(EPA Method - HACH_NO_3)
600049	CY65A-BNK-EB	NA	Water	ND (0.056)

[a]EPA November 1986.
[b]Analysis request/chain of custody record.

BNK = Bunker.
C = Ceiling.
CY = Canyon.
DU = Duplicate Analysis.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
N = Nitrogen.
NA = Not applicable.
ND = Not detected above the MDL, shown in parenthesis.
SWMU = Solid Waste Management Unit.
W = Wall.

at a beginning depth of 0 foot. The sample is designated a surface soil sample (SS). The remainder of this section summarizes the results of the characterization sampling at SWMU 65A.

The characterization sampling results were evaluated, and it was determined that no COCs were present in the surface soil surrounding the exterior of the bunker attributable to past explosives testing. During trenching around the perimeter of the bunker there was no visible evidence of contamination. Concentrations of HE and metals were slightly elevated in soil overlying the bunker floor and some of the interior foam had low concentrations of HE. Risk analyses using the interior soil data indicated that COCs were not present at concentrations that would pose a risk to human health under a recreational land use scenario. However, several of the metals concentrations inside the bunker were at levels slightly above ecological risk based values.

SNL/NM Waste Management reviewed the waste characterization sampling data to determine disposal options. Based upon these data it was determined that soil and debris associated with demolition and removal of the bunker could be disposed of as solid waste at the Kirtland Air Force Base landfill. The analytical results are discussed in more detail below.

Metals

Table 4.4.4-1 summarizes the on- and off-site metals analysis results for the samples collected from soil inside and outside the bunker at SWMU 65A. Six samples and one split sample were collected from the soil covering the bunker. Three samples, one matrix spike (MS), and one duplicate sample were collected from the soil residing inside the bunker. Results presented for the MS sample represent the prespike analysis results and can, therefore, be considered duplicate analyses of the corresponding primary sample. The first seven samples listed in Table 4.4.4-1 are designated grab samples (GR) in the ER Sample ID column and were collected from outside the bunker. The remaining five samples listed in the table are designated BNK in the ER Sample ID column and were collected from inside the bunker.

Outside Bunker Samples

As indicated in Table 4.4.4-1, the MDL for all on-site analyses of total metals exceeded the background concentration limits for arsenic, cadmium, chromium, mercury, selenium, and silver. However, the MDL for on-site analysis of mercury and chromium were very close to the background concentration limit. The off-site laboratories provided a lower MDL for metals analyses, with only a single exception. The MDL used by Lockheed Analytical Services for the analysis of mercury in sample CY65A-GR-003-1-S was 0.10 mg/kg.

Barium and beryllium were the only metals detected above the background concentration limits in the samples collected outside the bunker. Barium concentrations slightly exceeded the background limit in samples CY65A-GR-003-1-S and CY65A-GR-006-0-SS. Similarly, the beryllium concentration in split sample CY65A-GR-003-1-S was estimated to be slightly above the background limit. Chromium was not detected above the background concentration limit in any of the seven samples collected from outside the bunker. Similarly, lead was either not detected at or above the MDL or was not detected above the background concentration limit.

Inside Bunker Samples

Concentrations of arsenic were detected above the background concentration limit inside the bunker in sample CY65A-BNK-03-3.0 and the duplicate sample. Barium, beryllium, chromium, lead, and mercury levels were not detected above the background concentration limit inside the bunker. Cadmium was detected above the background concentration limit in each of the five samples collected from within the bunker. Selenium was detected significantly above the background concentration limit in sample CY65A-BNK-03-3.0 but was not detected above the background concentration limit in the duplicate sample CY65A-BNK-03-3.0-DU. Silver was detected above the background concentration limit in four of the five samples collected from within the bunker. Although silver (an estimated value) exceeded the background concentration limit in the duplicate sample CY65A-BNK-03-3.0-DU, sample CY65A-BNK-03-3.0 did not reveal silver above the MDL.

Table 4.4.4-2 summarizes the off-site TCLP metals analysis results for the two debris (foam) samples and one duplicate collected from within the bunker at SWMU 65A. The debris (foam) samples collected from the wall and ceiling of the bunker did not leach any RCRA metals above the toxicity characteristic levels for identification of RCRA hazardous wastes. In addition, beryllium was not detected above the MDL in the leachate generated by the TCLP analysis. *Table 4.4.4-3 summarizes the October 1998 TCLP metals analysis results from the composite* soil sample collected from the floor of the bunker and from the duplicate sample. The soil on the floor of the bunker did not leach any RCRA metals above the toxicity characteristic levels for identification of RCRA hazardous wastes.

HE

Table 4.4.4-4 summarizes the on- and off-site HE analysis results for the soil samples collected from nine locations inside and outside the bunker at SWMU 65A. The first seven samples listed in this table were collected from outside the bunker. The remaining five samples are designated BNK in the ER Sample ID column and were collected from inside the bunker.

No HE compounds were detected in any of the soil samples from inside or outside the bunker at SWMU 65A.

Table 4.4.4-5 summarizes the off-site TCLP HE analysis results for the two foam samples and one duplicate collected from within the bunker at SWMU 65A. 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane (HMX) was detected in all three samples at concentrations ranging from 82 to 210 μg/L.

Radionuclides

Table 4.4.4-6 summarizes the on-site gamma spectroscopy analysis results for one soil sample from outside the bunker and one soil and one debris (foam) sample from inside the bunker at SWMU 65A.

Table 4.4.4-7 summarizes the on-site gamma spectroscopy analysis of samples from the soil on the floor of the bunker and from a representative sample of the foam inside the bunker. Table 4.4.4-8 presents a summary of the off-site gross alpha/gross beta analysis results for all five soil and debris samples from inside the bunker, including two duplicates.

The gamma spectroscopy results indicate that no gamma activities above the background concentration limits were detected in the soil outside the bunker or the interior foam. However, the minimum detectable activities (MDA) used for the analysis of debris (foam) sample CY65A-BNK-04-C exceeded the background limits for each radionuclide presented in the table. In addition, the MDAs used for the analysis of uranium-235 in samples exceeded the 0.16-picocurie (pCi)/gram (g) background activity limit in all samples. However, because neither uranium-238 nor thorium-234 was detected above the background concentration limits, there is no basis to expect that elevated uranium-235 activity would exist in these two samples. Annex 4-B provides a summary of the Lurance Canyon Arroyo background sample results (NMED May 1997, NMED and DOE OB February 1998). Gamma spectroscopy results can be found in Annex 4-C.

Gamma spectroscopy analysis of samples from the soil on the bunker floor (Table 4.4.4-7) yielded no radionuclides above background, with the exception of uranium-235, which was detected at slightly above the background value of 0.16 pCi/g. The drum of foam had no gamma activity associated with it; however, detection limits were higher because of the type of test (waste characterization).

The gross alpha/gross beta activity results were all less than the background activity limits (Table 4.4.4-8).

<u>Nitrates</u>

Table 4.4.4-9 summarizes the nitrate analytical results for samples from inside the bunker. The concentration of nitrate (as N) in the soil samples ranged from 9.2 to 46 mg/kg. Nitrates (as N) in the foam ranged from 17 to 43 mg/kg.

<u>QA/QC Results</u>

This section briefly describes the QA/QC samples that were collected during the characterization sampling. Two equipment blanks were collected and analyzed off site for metals. Sample CY65A-GR-008-EB was collected during the May 1996 sampling conducted outside the bunker, and sample CY65A-BNK-EB was collected during the March 1998 sampling conducted inside the bunker. No metals were detected in sample CY65A-GR-008-EB. Although barium, lead, and selenium were detected above MDLs in sample CY65A-BNK-EB, the levels were low as compared to the environmental soil sample results.

One duplicate sample, one split sample, and one MS sample were also collected. The sample CY65A-GR-003-1-S (analyzed off site) is a split of sample CY65A-GR-003-1-S (analyzed on site). Sample CY65A-BNK-01-0.0-MS (analyzed off site) can be considered a duplicate of sample CY65A-BNK-01-0.0 because the results presented in Table 4.4.4-10 represent the prespike analysis. Comparable results were obtained for the sample pair CY65A-GR-003-1-S and CY65A-GR-003-1-S (MS) and sample pair CY65A-BNK-01-0.0 and

Table 4.4.4-10
Summary of SWMU 65A Field Duplicate Relative Percent Differences

Sample Attributes			Relative Percent Difference								
Record Number[a]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600051	CY65A-BNK-01-0.0 CY65A-BNK-01-0.0-MS (off-site laboratory)	0.0	NC	8.4	0.8	33.1	23.7	48.6	NC	NC	5.6
60051	CY65A-BNK-03-3.0 CY65A-BNK-03-3.0-DU (off-site laboratory)	3.0	37.9	10.4	0.5	14.0	20.9	8.9	NC	NC	NC

[a]Analysis request/chain of custody

BNK = Bunker.
CY = Canyons.
DU = Duplicate sample.
ER = Environmental restoration.
ft = Feet (feet).
ID = Identification.
MS = Matrix spike, reported values represent analytical results prior to the addition of the matrix spike.
NC = Not calculated for estimated values and nondetected results.
SWMU = Solid Waste Management Unit.

CY65A-BNK-01-0.0-MS. However, comparable results were not obtained for selenium and silver in the sample pair CY65A-BNK-03-3.0 and CY65A-BNK-03-3.0-DU. Table 4.4.4-10 summarizes the relative percent difference for metal analyses. In general, the precision for most metals was less than the 25-percent acceptance limit with the exception of arsenic in the CY65A-BNK-03 sample pair and cadmium and lead in sample pair CY65A-BNK-01.

One TCLP metals QA/QC sample was collected during the characterization sampling program at SWMU 65A. It is the duplicate sample CY65A-BNK-04-C-DU. Comparable results were obtained for the sample pair.

Two QA/QC samples (equipment blanks) were collected and analyzed off site for HE compounds (Table 4.4.4-4). Sample CY65A-GR-008-EB was collected during the May 1996 sampling conducted outside the bunker, and sample CY65A-BNK-EB was collected during the March 1998 sampling conducted inside the bunker. One split sample and one MS sample were also collected. Comparable results were obtained for the sample pairs CY65A-GR-003-1-S and CY65A-GR-003-1-S and CY65A-BNK-03-3.0 and CY65A-BNK-03-3.0-DU.

One TCLP HE QA/QC sample was collected (Table 4.4.4-5). It is the duplicate sample CY65A-BNK-04-C-DU. Comparable results were obtained for the sample pair.

No QA/QC samples were collected for gamma spectroscopy analysis. Three QA/QC samples were collected for gross alpha/gross beta analysis, including an equipment blank and two duplicates (Table 4.4.4-8). Although gross alpha activity was detected in the equipment blank, gross beta activity was not detected. Comparable results were obtained for sample CY65A-BNK-03-3.0 and the duplicate. Some discrepancies are noted in the gross alpha/gross beta results for sample CY65A-BNK-04-C and the duplicate, which ranged from 0.970 to 2.45 pCi/g and from 15.8 to 9.83 pCi/g, respectively.

Data Validation

SNL/NM Department 7713 (RPSD Laboratory) reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). In addition all off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3-DV3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). Annex 4-D contains off-site data validation reports. The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 65A.

4.4.5 VCA and Confirmatory Sampling

4.4.5.1 Project Planning

In October 1998 SNL/NM decided that a VCA should be conducted and would include demolition and removal of the SWMU 65A bunker. The bunker represents a slight ecological hazard and a definite physical hazard for future recreational visitors. After meeting with the NMED/DOE Oversight Bureau to discuss the scope of the VCA, a VCA plan was prepared and submitted to the DOE for review. The VCA plan (SNL/NM, January1999) consisted of demolition, removal and disposal of the bunker, and the collection of confirmatory samples under the floor of the bunker. The bunker demolition, removal and confirmatory sample results are presented in the following sections.

4.4.5.2 Bunker Demolition and Removal

The SWMU 65A bunker was excavated and demolished on March 1, 1999. A backhoe was used to excavate the soil from around the outside perimeter of the bunker. An excavator with a pneumatic hammer was then used to break the concrete bunker into small enough pieces to load in roll-offs. There was no visible evidence of contamination or damage from fire/explosion visible in the concrete, wood/foam (except bunker interior) or in the soil surrounding the bunker during demolition. The large volume of foam and wood debris precluded segregating the concrete from this material for beneficial reuse. Over a several week period (as roll-offs were available) five 20 cubic yard roll-offs were filled and transported to the Kirtland Air Force Base landfill for disposal. Photographs showing demolition of the bunker and waste staging are presented as Figure 4.4.5-1a/b and Figure 4.4.5-2 a/b.

4.4.5.3 Confirmatory Soil Sampling

On March 8, 1999, samples were collected from two locations at the bottom of the bunker excavation. The objective of this sampling was to verify that no COCs were present in soil after removal of the bunker. The surface soil samples were analyzed for RCRA metals plus beryllium, and total uranium and HE. GEL Laboratories of Charleston, South Carolina, analyzed the samples for RCRA metals plus beryllium and uranium using EPA Methods 6010/7000 (EPA November 1986) and for HE using EPA Method 8330 (EPA November 1986). The surface soil samples were also analyzed at RPSD using gamma spectroscopy. Figure 4.4.5-3 shows sample locations. Table 4.4.5-1 summarizes metals results and Table 4.4.5-2 summarizes HE results. Table 4.4.5-3 summarizes the detection limits used for analyzing HE compounds by the off-site laboratories. Table 4.4.5-4 presents gamma spectroscopy results. A duplicate sample and a rinsate sample were collected with the surface soil samples.

No metals were detected in the samples at concentrations above background. There were no detection's of HE in the surface soil samples. With the exception of one gamma activity slightly above background for uranium-235, gamma activities were within the natural background range. The MDAs for the gamma spectroscopy results were below Canyons Area background levels. These data confirm that low-level contamination was confined to soil and material inside the bunker and that the VCA successfully removed this material.

<u>Quality Assurance/Quality Control Results</u>

During confirmatory sampling at SWMU 65A a duplicate sample and an equipment rinsate sample were collected. There was good correlation between the original sample and the duplicate (Table 4.4.5-5) for the metals analyses. All HE data were nondetect; therefore, RPSD was not calculated for these data. There was reasonably good correlation for gamma spectroscopy results between the original sample and the duplicate. No metals or HE were detected in the equipment blank with the exception of an extremely low detection of silver.

Figure 4.4.5-1a Demolition of SWMU 65A Bunker.

Figure 4.4.5-1b Partially Demolished Bunker. Note that Interior Foam, Wood and Concrete Appears Undamaged.

Figure 4.4.5-2a SWMU 65A Bunker After Demolition.

Figure 4.4.5-2b Loading Debris Into Roll-off for Disposal at KAFB Landfill.

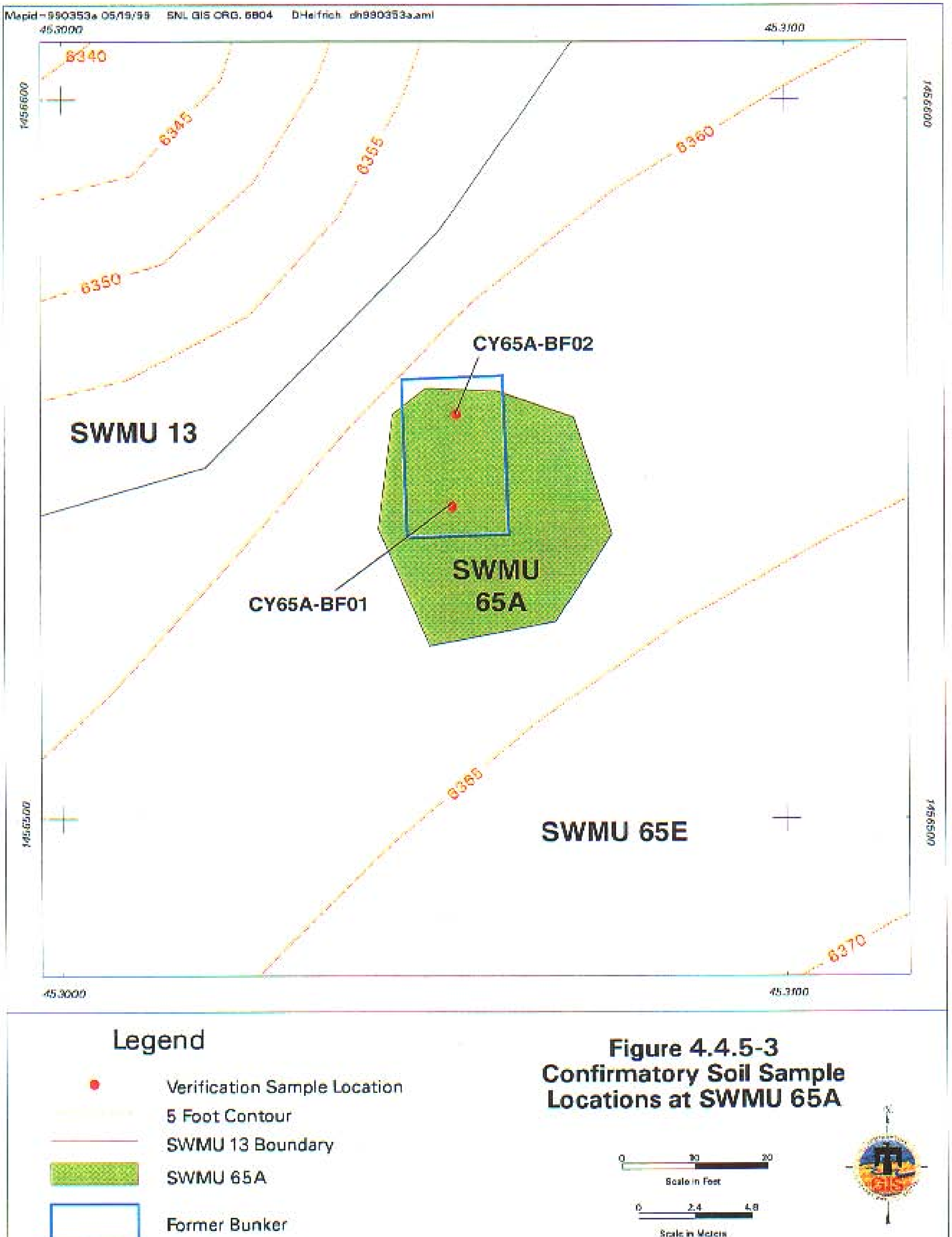

Figure 4.4.5-3
Confirmatory Soil Sample Locations at SWMU 65A

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Table 4.4.5-1
Confirmatory Soil Sampling Metals Analytical Results
(March 1999)

Sample Attributes			Metals (EPA Methods 6010/7000[a]) (mg/kg)									
Record Number[b]	ER Sample ID (Figure 4.4.5-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Uranium
Under Bunker Floor												
601644	CY65A-GR-BF01-SS	0.0–0.5	4.73	162	0.621	0.222 J	15.3	10.9	0.0233 J	ND (0.135)	0.227 J	0.730
601644	CY65A-GR-BF02-SS	0.0–0.5	4.63	154	0.663	0.250 J	14.7	9.96	0.0162 J	ND (0.135)	0.293 J	0.582
601644	CY65A-GR-BF02-DU	0.0–0.5	4.62	163	0.655	0.217J	13.8	9.12	0.0160 J	ND (0.135)	0.232 J	0.640
Background Soil Concentrations, Canyon Area[c]			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5	3.42
Quality Assurance/Quality Control Sample (mg/L)												
601644	CY65A-GR-BF03-EB	NA	ND (0.00451)	ND (0.00051)	ND (0.00026)	ND (0.00044)	ND (0.00056)	ND (0.00159)	ND (0.000035)	ND (0.00271)	0.000738 J	ND (0.0000251)

[a]EPA November 1986.
[b]Analysis request/chain of custody.
[c]From SNL/NM December 1997.

BF = Bunker Floor (under).
CY = Canyon.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Analytical result was qualified as an estimation during validation.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
SS = Surface soil sample.

Table 4.4.5-2
Confirmatory Soil Sampling HE Analytical Results
(March 1999)

Sample Attributes			Explosives (EPA Method 8330[a])(µg/kg)						
Record Number[b]	ER Sample ID (Figure 4.4.5-3)	Sample Depth (ft)	2,4,6-trinitrotoluene	2,4-dinitrotoluene	2,6-dinitrotoluene	2 amino 4,6-dinitrotoluene	4 amino 2,6-dinitrotoluene	o-nitrotoluene (2)	m-nitrotoluene (3)
Under Bunker Floor									
601644	CY65A-GR-BF01-SS	0.0–0.5	ND (5.7)	ND (6.2)	ND (6.5)	ND (6.6)	ND (5.5)	ND (7.8)	ND (11)
601644	CY65A-GR-BF02-SS	0.0–0.5	ND (5.7)	ND (6.2)	ND (6.5)	ND (6.6)	ND (5.5)	ND (7.8)	ND (11)
601644	CY65A-GR-BF02-DU	0.0–0.5	ND (5.7)	ND (6.2)	ND (6.5)	ND (6.6)	ND (5.5)	ND (7.8)	ND (11)
Quality Assurance/Quality Control Sample (µg/L)									
601644	CY65A-GR-BF03-EB	NA	ND (0.029)[d]	ND (0.014)[d]	ND (0.043)[d]	ND (0.019)[d]	ND (0.02)[d]	ND (0.024)[d]	ND (0.031)[d]
			p-nitrotoluene (4)	Nitrobenzene	m-dinitrobenzene	sym-trinitrobenzene	RDX	Tetryl	HMX
Outside Bunker									
601644	CY65A-GR-BF01-SS	0.0–0.5	ND (11)	ND (5.2)	ND (4.1)	ND (6.6)	ND (9.7)	ND (7.5)	ND (5.3)
601644	CY65A-GR-BF02-SS	0.0–0.5	ND (11)	ND (5.2)	ND (4.1)	ND (6.6)	ND (9.7)	ND (7.5)	ND (5.3)
601644	CY65A-GR-BF02-DU	0.0–0.5	ND (11)	ND (5.2)	ND (4.1)	ND (6.6)	ND (9.7)	ND (7.5)	ND (5.3)
Quality Assurance/Quality Control Sample (µg/L)									
601644	CY65A-GR-BF03-EB	NA	ND (0.034)	ND (0.016)	ND (0.02)	ND (0.021)	ND (0.018)	ND (0.022)	ND (0.046)

Note: **Bold** indicates a detection for an HE analyte.

[a]EPA November 1986.
[b]Analysis request/chain of custody.

BF = Bunker Floor (under).
CY = Canyon.
EB = Equipment blank.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
HE = High explosive(s).
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
ID = Identification.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.
Tetryl = 2,4,6-trinitrophenylmethylnitramine.

Table 4.4.5-3
Summary of HE Analysis Detection Limits
Used for SWMU 65A Confirmatory Soil Sampling, April 1998 and March 1999

Compounds	Off-Site Analyses Using EPA Method 8330[a] (µg/kg)
1,3,5-trinitrobenzene	6.6–32
1,3-dinitrobenzene	4.1–16
2,4,6-trinitrotoluene	5.7–19
2,4-dinitrotoluene	6.2–17
2,6-dinitrotoluene	6.5–17
2-amino-4,6-dinitrotoluene	6.6–17
2-nitrotoluene	11–41
3-nitrotoluene	7.8–30
4-amino-2,6-dinitrotoluene	5.5–79
4-nitrotoluene	11–31
HMX	5.3–24
Nitrobenzene	5.2–9.0
Pentaerythritol tetranitrate	NA
RDX	9.7–31
Tetryl	7.5–94

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
HE = High explosive(s).
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
NA = Not applicable.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.
µg/kg = Microgram(s) per kilogram.

Table 4.4.5-4
Gamma Spectroscopy Analytical Results (RPSD)
March 1999

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
			Uranium-238		Thorium-232		Uranium-235		Cesium-137	
Record Number[a]	ER Sample ID (Figure 4.4.5-3)	Sample Depth (ft)	Results	Error[b]	Results	Error[b]	Results	Error[b]	Results	Error[b]
Under Bunker Floor										
601645	CY65A-BF01-SS	0.0–0.5	ND (0.704)	--	0.846	+/-0.454	0.105	+/-0.165	ND (0.0169)	--
601645	CY65A-BF02-SS	0.0–0.5	ND (0.753)	--	0.777	+/-0.431	0.159	+/-0.171	ND (0.0293)	--
601645	CY65A-BF02-DU	0.0–0.5	ND (0.794)	--	0.805	+/-0.452	**0.192**	+/-0.185	ND (0.0320)	--
Background Soil Concentrations, Upper Canyons[c]			2.31	NA	1.03	NA	0.16	NA	0.515	NA

Note: **Bold** indicates values that exceed background soil concentrations.
[a]Analysis request/chain of custody
[b]Two standard deviations above the mean detected activity.
[c]From Zamorski December 1997.
BF = Bunker Floor (under).
CY = Canyons.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
RPSD = Radiation Protection Sample Diagnostics.
SS = Surface soil.
-- = Error not calculated for nondetectable results.

Table 4.4.5-5
Summary of SWMU 65A Field Duplicate Relative Percent Differences
(Confirmatory Sampling)

Sample Attributes			Relative Percent Difference								
Record Number[a]	ER Sample ID (Figure 4.4.5-3)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
601644	CY65A-GR-BF02-SS CY65A-GR-BF02-DU	0.0–0.5	0.2	5.7	0.3	14.1	6.3	8.8	1.2	NC	23.2

[a]Analysis request/chain of custody

BF = Bunker Floor (under).
CY = Canyons.
DU = Duplicate sample.
ER = Environmental restoration.
ft = Feet (feet).
GR = Grab sample.
ID = Identification.
NC = Not calculated for estimated values and nondetected results.
SS = Surface soil.
SWMU = Solid Waste Management Unit.

Data Validation

SNL/NM Department 7713 (RPSD Laboratory) reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996).

In addition all off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3-DV3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). Annex 4-D contains off-site data validation reports. The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 65A.

4.5 Site Conceptual Model

The site conceptual model for SWMU 65A is based upon historical data and upon the residual COCs identified in the samples from the soil and material associated with the bunker. These data suggest that the small bunker was used in an explosives propagation test. The interior of SWMU 65A burned, possibly because of the detonation of a large bomb outside the bunker. Soil from the bunker floor had low concentrations of HE and three metals (arsenic, cadmium, silver) and some of the interior foam had HE residue on it. Soil from outside the bunker yielded no contamination.

4.5.1 Nature and Extent of Contamination

The COCs at SWMU 65A are metals (including DU) and HE compounds possibly associated with a single propagation test. The materials used in the propagation test include metal weapons casings and HE (SNL/NM September 1995). No other tests are known to have been conducted at the site, and there is no documented evidence of burial or disposal activities at the site. Six environmental samples were collected from outside the bunker at SWMU 65A from within three trenches. After removal of the bunker two additional samples were collected from the area under the floor of the bunker. Table 4.5.1-1 summarizes the COCs for SWMU 65A. Because the bunker itself was removed during the VCA, analytical results of soil and material within the bunker are not included in the development of COCs.

Metal COCs were determined on the basis of any potential contaminant exceeding the background concentration limit in any soil sample. Outside the bunker beryllium and barium slightly exceed the background concentration limits with no particular COC associations or areas that could be delineated as contaminated. However, the MDLs used in the analysis of most samples collected outside the bunker were significantly above the background concentration limits for arsenic, cadmium, mercury, selenium, and silver. In the case of nondetectable results, the MDL for metals is used for comparison to the background concentration limit. As a result, metal COCs include arsenic, barium, beryllium, cadmium, mercury, selenium, and silver.

HE COCs were determined on the basis of detectable concentrations of HE compounds in any soil sample. Because background concentrations for HE compounds are not applicable, any detectable HE compounds are considered potential contamination. However, no HE compounds were detected in soil inside or outside the bunker and nondetectable results are, therefore, not considered for evaluating potential HE COCs.

Table 4.5.1-1
Summary of COCs for SWMU 65A

COC Type	Number of Samples	COCs Greater Than Background	Maximum Background Limit/Canyons[a] (mg/kg except where noted)	Maximum Concentration (mg/kg except where noted)	Average Concentration[b] (mg/kg except where noted)	Sampling Locations Where Background Concentration Exceeded
Metals	6 environmental; 1 split	As	9.8	ND (26)	23.0	All on-site analyses[c]
		Ba	246	250	227.1	CY65A-GR-003-1-S CY65A-GR-006-0-SS
		Be	0.75	0.78 J	0.21	CY65A-GR-003-1-S (split)
		Cd	0.64	ND (2.1)	1.87	All on-site analyses[c]
		Hg	0.055	ND (0.10)	0.066	All on-site and off-site analyses[d]
		Se	2.7	ND (50)	43	All on-site analyses[c]
		Ag	<0.5	ND (1.7)	1.5	All on-site analyses[c]
Radiological	1 environmental	U-235	0.16 pCi/g	ND (2.18E-01)	Not calculated[e]	

[a]From Zamorski December 1997.
[b]Average concentration includes all samples, duplicates, and splits. For nondetects, the detection limit is used to calculate the average.
[c]The detection limits used in the on-site analyses for arsenic, cadmium, selenium, and silver were above the background concentration limit.
[d]The detection limits used in on-site and off-site analysis for mercury were above the background concentration limit.
[e]An average minimum detectable activity is not calculated because of variability in instrument counting error and the number of reported nondetectable activities.

COC = Constituent of concern.
J = The reported value is greater than or equal to the method detection limit but is less than the contract required detection limit for metals.
mg/kg = Milligram(s) per kilogram.
ND ( ) = Not detected at or above the method detection limit, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

One soil sample from the soil covering the bunker was collected and analyzed for gamma-emitting radionuclides. Only uranium-235 activity (0.218 pCi/g) slightly exceeded the background activity limit of 0.16 pCi/g. However, uranium-238 and thorium-232 are listed as potential radiological COCs because of the potential for DU from activities at SWMU 65E.

4.5.2 Environmental Fate

It is believed that the primary source of COCs for SWMU 65A would be from a single detonation propagation test that had been conducted at the site. Materials used in the propagation test included metal weapons casings and HE (SNL/NM September 1995). The primary release mechanism of COCs resulted from detonation of the test explosives. Based upon the intact condition of the bunker, no release of COCs outside the bunker occurred during the propagation test. Because the bunker itself was removed from the site, only secondary sources of COCs remain from soil covering the bunker (or soil under the bunker).

Table 4.5.1-1 summarizes potential COCs for SWMU 65A. Based upon the nature and extent of contamination at the site, only metal and radiological COCs occur in the soil outside the bunker at concentrations elevated above the maximum background concentrations. Barium and beryllium were detected in the soil at concentrations slightly above the maximum background concentrations. Uranium-238, uranium-235, and thorium-232 were included as potential COCs, although they only slightly exceeded background activity limit. All potential COCs were retained in the conceptual model and were evaluated in the human health and ecological risk assessments (Annex 4-E).

There were no detections of HE compounds or metals in soil under the bunker floor. Uranium-235 was detected slightly above background in the duplicate sample; however, the activity in the other sample was within the background range.

If the propagation test released contamination to the surrounding environment, the secondary source of COCs is residual metals in the soil remaining outside the bunker. Confirmatory sampling and visual inspection of the bunker indicate that the integrity of the bunker was not compromised by an explosive detonation. The secondary release mechanisms at SWMU 65A are limited to the suspension and/or dissolution of COCs in the surface soil to surface-water runoff and subsequent percolation to the vadose zone, dust emissions, and the uptake of COCs in the soil by biota (Figure 4.5.2-1). However, the depth to groundwater at the site is approximately 222 feet bgs and occurs under semiconfined to confined conditions that preclude the migration of COCs to the aquifer. In addition, high partitioning coefficients and low mobility in the transporting medium would enhance dilution of the already low COC concentrations. The pathways to receptors are surface water, soil water, air, and soil. Biota are also a pathway through food chain transfers. Annex 4-E, Section V, provides additional discussion of the fate and transport of COCs at SWMU 65A.

The current land use for SWMU 65A is industrial. However, because the future land use for SWMU 65A is recreational (DOE et al. October 1995), the potential human receptor is considered a recreational user of the site. For all applicable pathways, the exposure route for the recreational user is ingestion/inhalation. Potential biota receptors include flora and fauna at the site. Similar to the recreational user, direct ingestion of soil is considered the major exposure route for biota, in addition to the ingestion of COCs through food chain transfers or the

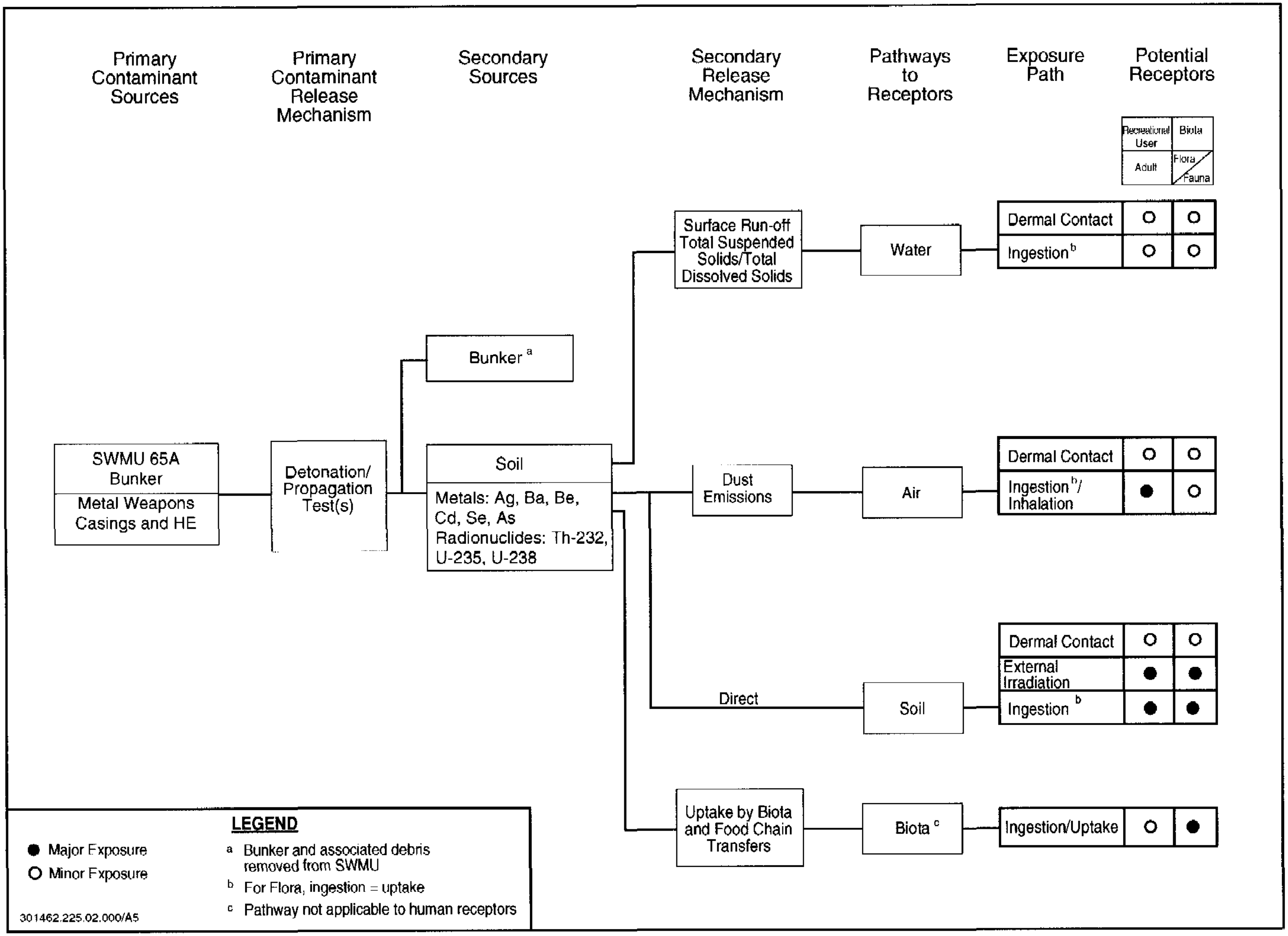

Figure 4.5.2-1

Conceptual Model Flow Diagram for SWMU 65A, Small Debris Mound

direct uptake of COCs. Annex 4-E, Section V, provides additional discussion of the exposure routes and receptors at SWMU 65A.

4.6 Site Assessments

The site assessment process for SWMU 65A includes risk screening assessments followed by risk baseline assessments (as required) for both human health and ecological risk. This section briefly summarizes the site assessment results. Annex 4-E provides details of the assessment.

4.6.1 Summary

The site assessment concludes that SWMU 65A does not have potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 65A were found to be very low. Section 4.6.2 briefly describes and Annex 4-E provides details of the site assessments.

4.6.2 Screening Assessments

Risk screening assessments were performed for both human health risk and ecological risk for SWMU 65A. The following discusses the results.

4.6.2.1 Human Health

SWMU 65A has been recommended for recreational land-use (DOE et al. October 1995). Annex 4-E provides a complete discussion of the risk assessment process, results, and uncertainties. Because of the presence of COCs in concentrations or activities greater than background levels, it was necessary to perform a health risk assessment analysis for the site. Besides COC metals, this assessment included any HE compounds detected above their reporting limits and any radionuclide COCs detected either above background levels and/or MDAs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in soil at the site. The Risk Screening Assessment Report calculated the hazard index (HI) and excess cancer risk for a recreational land-use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

In summary, the HI calculated for SWMU 65A nonradiological COCs is 0.00 for a recreational land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. There is no incremental HI. The excess cancer risk for SWMU 65A nonradiological COCs is 8E-7 for a recreational land-use setting, which is also below the acceptable risk value provided by the NMED for recreational land use (NMED March 1998). The incremental cancer risk for SWMU 65A is 2E-7. Because measured radiological activity concentrations were all below the appropriate SNL/NM background values, no radiological risk assessment was performed.

The residential land-use scenarios for this site are provided only for comparison in the Risk Screening Assessment Report (Annex 4-E). The report concludes that SWMU 65A does not have potential to affect human health under a recreational land-use scenario.

4.6.2.2 Ecological

An ecological screening assessment that corresponds with the screening procedures in EPA's ecological risk assessment guidance document for Superfund (EPA 1997) was performed as set forth by the NMED Risk-Based Decision Tree (NMED March 1998). An early step in the evaluation is comparing COC concentrations and identifying potentially bioaccumulative constituents. This is presented in Annex 4-E, Sections V, VII.2, and VII.3. This methodology also requires that a site conceptual model and a food web model be developed and that ecological receptors be selected. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology" for the SNL/NM ER Program (IT July 1998) and will not be duplicated here. The screen also includes the estimation of exposure and ecological risk.

Tables 14 and 15 of Annex 4-E present the results of the ecological risk assessment screen. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients greater than unity were originally predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in the estimation of risk), exposure setting (area use factors of one were assumed), background risk, and the use of detection limits as exposure concentrations. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be insignificant.

4.6.3 Risk Assessments

This section discusses the baseline risk assessment for human health and ecological risk.

4.6.3.1 Human Health

Based upon the fact that human health results of the screening assessment summarized in Section 4.6.2.1 indicate that SWMU 65A does not have the potential to affect human health under a recreational land-use setting, a baseline human health risk assessment is not required for SWMU 65A.

4.6.3.2 Ecological

Based upon the fact that ecological results of the screening assessment summarized in Section 4.6.2.2 indicate that SWMU 65A has very low ecological risk, a baseline ecological risk assessment is not required for SWMU 65A.

4.6.4 Other Applicable Assessments

4.6.4.1 Surface Water

As specified in the OU 1333 Work Plan (SNL/NM September 1995), background arroyo sediment samples were collected from the section of the Lurance Canyon Arroyo (and tributaries) immediately upstream from SWMU 65D. The samples were analyzed for metals and radionuclides. Based upon the RSI (Dinwiddie August 1997), the analyses specified for background arroyo sediment samples were expanded to include gross alpha/gross beta. Because investigation of the Lurance Canyon arroyo has been included in the ongoing SNL/NM Surface-Water Monitoring Program (SNL/NM in progress), an assessment of the results obtained for the background arroyo sediment sampling activities is not included in the SWMU 65A NFA. However, Annex 4-B presents a summary of the Lurance Canyon Arroyo background sample results (NMED May 1997, NMED and DOE OB February 1998).

4.6.4.2 Groundwater

Based upon NMED concerns regarding nitrate concentrations detected in groundwater samples collected from the Burn Site production well (SNL/NM July 1997, SNL/NM September 1997) and contaminant concentrations in wastewater stored in aboveground tanks at the Burn Site (Dinwiddie August 1997), investigation of groundwater in the Canyons Area was initiated. Pursuant to the RSI (Dinwiddie August 1997), the SWMU 12A piezometer and the Narrows Well pair were installed. Since the installation of the SWMU 12A piezometer in November 1996 and the Narrows Well piezometer CYN-MW2S in February 1998, no groundwater has been detected at the bedrock/alluvium contact. Pursuant to a notice of deficiency (Garcia March 1998), groundwater samples are collected at the Narrows Well once every three months. Low levels of petroleum hydrocarbons were present in groundwater samples from the first and second monitoring events for this well. No detected compounds exceed federal maximum contaminant levels (MCLs) with the exception of nitrate, which is at or just above the MCL of 10 mg/L (DOE November 1998).

4.7 No Further Action Proposal

4.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is being recommended for SWMU 65A for the following reason: No COCs (metals and radionuclides) are present in concentrations considered hazardous to human health for a recreational land-use scenario and removal of the bunker has eliminated the potential physical hazard posed.

4.7.2 Criterion

Based upon the evidence provided above, SWMU 65A is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states, "The SWMU/AOC has been characterized or remediated in accordance with current applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

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ANNEX 4-A
Summary of Testing Activities at SWMU 65, Lurance Canyon Explosive Test Site

The Lurance Canyon Explosives Test Site (LCETS) was used for explosive testing from the late-1960s to the early 1990s. Testing programs at the LCETS can be grouped into the following six categories:

- General explosive tests
- Burn pit tests (fuel fire)
- Miscellaneous burn tests (nonfuel fire)
- Cone tests
- Torch-activated burn system (TABS)
- Slow-heat tests

The following sections describe the six types of explosive/burn testing associated with Solid Waste Management Unit (SWMU) 65 subunits. Figures 4A-1 and 4A-2 show the general locations of these tests.

A.1 GENERAL EXPLOSIVES TESTS

SWMU 65 was designed with a 10,000-foot dispersion radius to provide an adequate buffer for detonating up to 10,000 pounds (lb) of high explosive (HE) (Gaither et al. May 1993a, Author [unk] Date [unk]a, Larson and Palmieri August 1994a, Larson and Palmieri August 1994b). When construction of the SWMU 94 burn structures began in 1977, the explosives testing limit was reduced to 1,000 lb (Martz September 1985). Most of the explosives tests were conducted in the disturbed areas designated SWMU 65B (Larson and Palmieri August 1994a, Larson and Palmieri August 1994b), and SWMU 65C (Littrel February 1969, Karas June 1993, Foy April 1971, Clark December 1970, Walkington April 1973, Stravasnik September 1972). Explosives tests were conducted at grade or at 2 to 3 feet above grade (Gaither et al. May 1993b). Fragments may have been widely scattered over the site (Gaither Date [unk.], Gaither October 1992, Martz November 1985, DOE September 1987), and material may also have been driven into the ground at the detonation location (Gaither et al. May 1993a). Metal shrapnel has been found and observed in an area defined by a circular perimeter with an approximate radius of 1,000 feet centered on the primary detonation area (Hickox November 1994). Past test locations are not currently visible because of ongoing grading and construction activities associated with SWMU 94.

Materials that may have been involved in general explosives tests include HE, depleted uranium (DU), lead, aluminum powder, fuel-rod shipping containers, steel slurry vessels, and live and mock weapons (Gaither et al. May 1993a, Gaither Date [unk.], Gaither October 1992, Karas June 1993, Mortz November 1985, Larson and Palmieri August 1994a, Larson and Palmieri August 1994b, Palmieri November 1994a, Palmieri December 1994a, Palmieri December 1994b, DOE September 1987). Details on known tests are given below.

A.1.1 Open-Detonation Tests

It is expected that other HE tests were conducted at SWMU 65 for which no specific information is available in the current archive records. Archive records state that 15 to 20 HE tests per year were conducted at SWMU 65 between 1968 and 1980 (Gaither et al. May 1993a, Author [unk]

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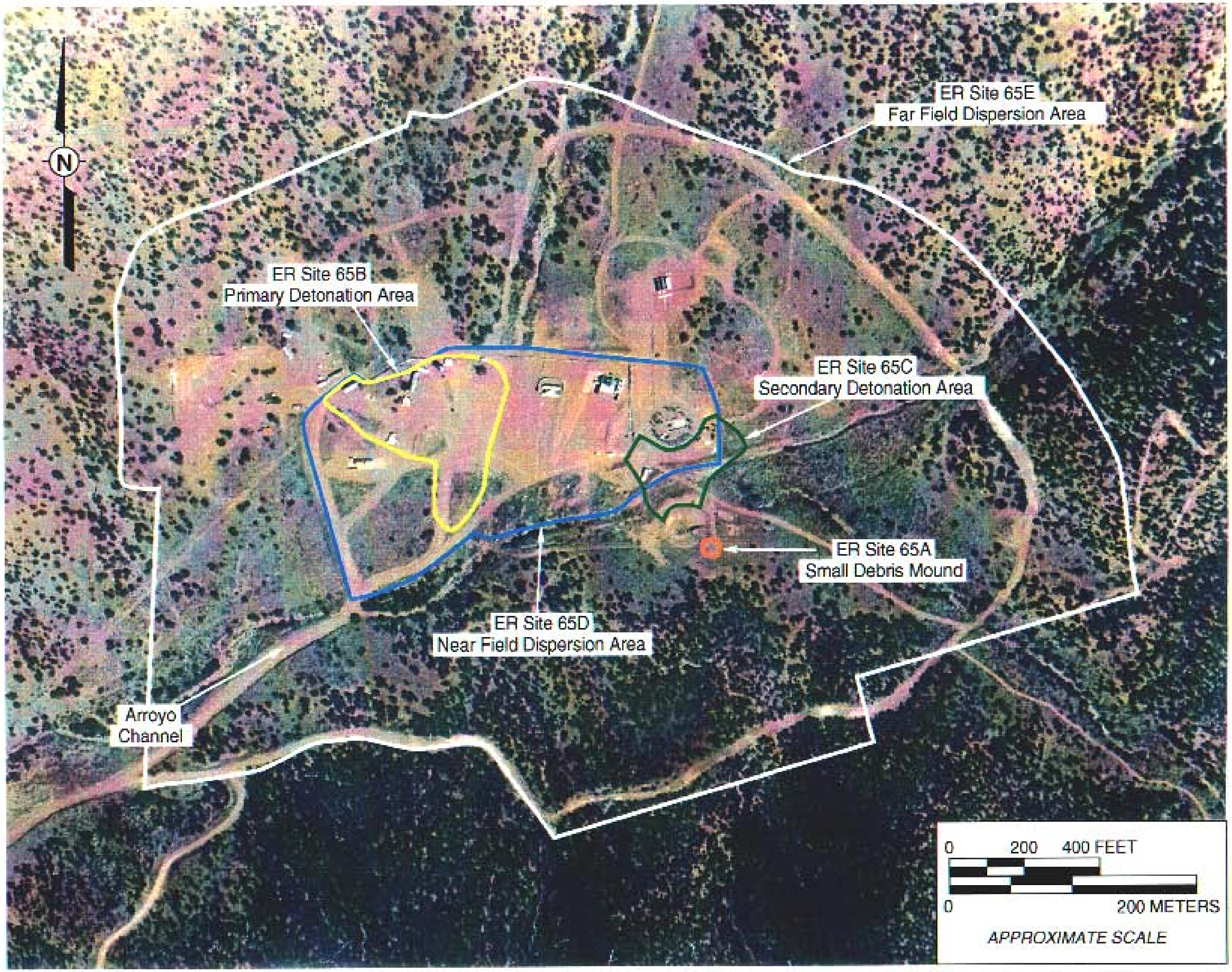

Low-altitude photograph of Lurance Canyon in 1992. ER Site 65 subunits are identified.

Figure 4A-1

SWMU 65, Lurance Canyon Explosive Test Site, Designated Subunits

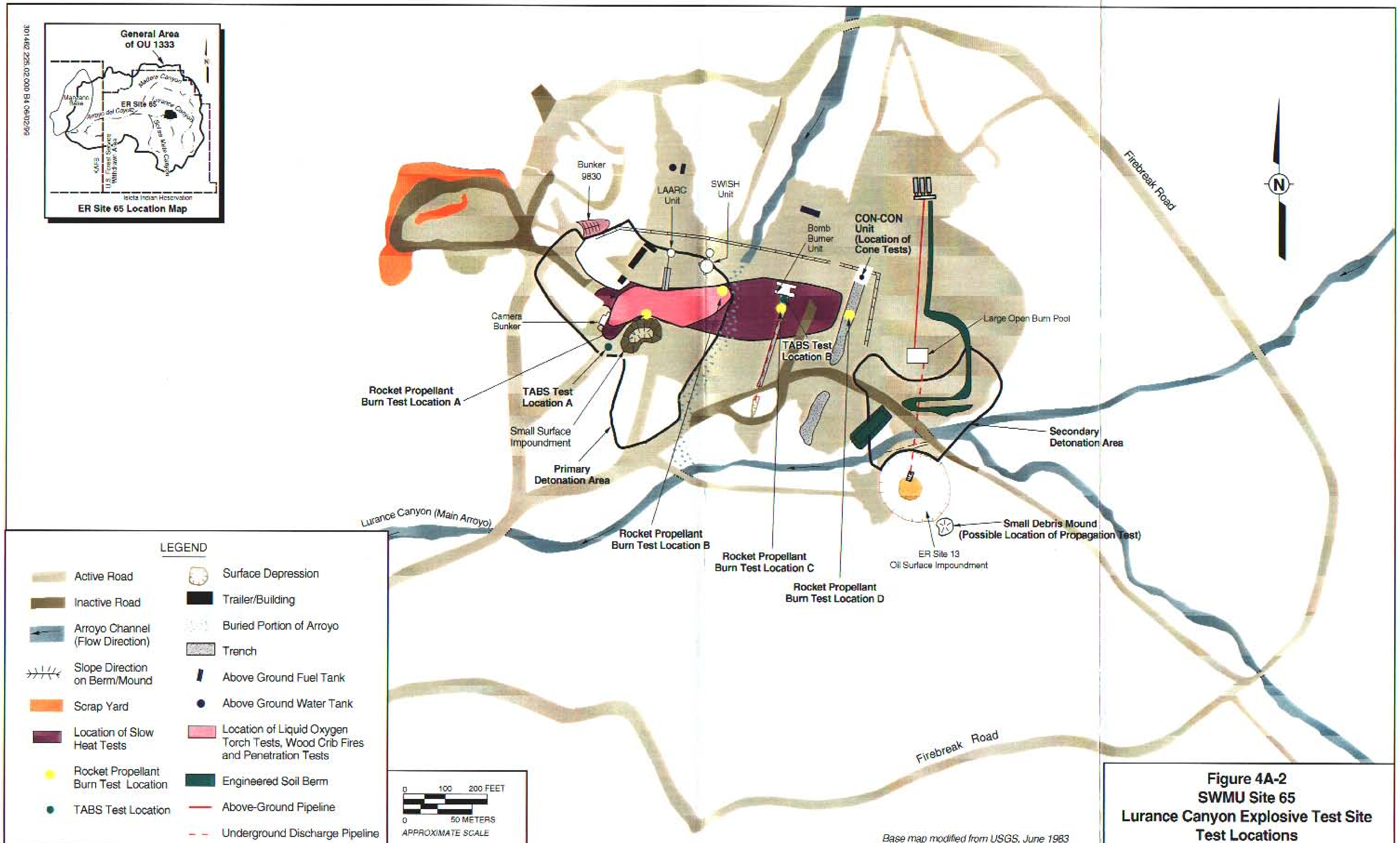

Figure 4A-2
SWMU Site 65
Lurance Canyon Explosive Test Site
Test Locations

Date [unk]a). However, it was not possible to obtain information or specific records on all of these tests.

A.1.2 Ammonium Nitrate/Fuel Rod Shipping Container Test

An explosives test was performed at SWMU 65 with fuel-rod shipping containers and an ammonium nitrate slurry bomb (Gaither et al. May 1993a, Larson and Palmieri August 1994b, DOE September 1987). The test was conducted with 4,000 lb of ammonium nitrate slurry to evaluate the impact of the detonation on the integrity of two containers. The containers were reportedly dented but not fragmented from the detonation (Gaither et al. May 1993a, Karas June 1993, Larson and Palmieri August 1994b). A specific location for the test was not given, but large detonations were reported to have taken place in the secondary detonation area (SWMU 65C) near the area now occupied by the Large Open Burn Pool (LOBP) (Palmieri December 1994b).

A.1.3 Penetration Tests

Bullet penetration tests on B-61 warheads containing DU surrounded by HE (Larson and Palmieri August 1994b) were conducted at SWMU 65B between 1980 and 1985 (Gaither et al. May 1993a, Palmieri December 1994b). These tests consisted of firing a high-velocity projectile into the B-61 warhead to detonate the HE and fragment the weapon (Larson and Palmieri August 1994b). The tests were conducted in the region between the camera bunker and the northeast-southwest-trending arroyo channel located on the east side of the primary detonation area (Larson and Palmieri August 1994b).

A.1.4 Propagation Test

One interview record noted that two live weapons were used in a propagation test conducted in a concrete bunker (SWMU 65A) in the area adjacent to SWMU 13, Oil Surface Impoundment. The test may have taken place between 1965 and 1979 (Palmieri December 1994a). One weapon was placed inside the bunker and one was placed outside the bunker (Palmieri November 1994a). The test was designed to determine whether the shock wave created by the detonation of the weapon outside of the bunker could detonate the weapon on the inside. The weapon inside the bunker did not detonate (Palmieri November 1994a). The small debris mound possibly associated with this test is designated SWMU 65A.

A.2 BURN PIT TESTS (FUEL FIRE)

Burn tests were conducted on weapons components, reentry vehicles, ammonium nitrate bombs, and nuclear materials containers at SWMU 65C. Burn tests at SWMU 65 began in approximately 1969 (Littrel February 1969, Karas June 1993) and were initially carried out in excavated pits. The burn pits were replaced by portable pans before 1979 (Jercinovic et al. November 1994). Burn tests in portable pans (Figure 4A-3) will be discussed in SWMU 94 no further action proposals.

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Photograph of portable pans in the southern portion of the scrap yard in April 1995. The pans held JP-4 fuel and water used in small-scale burn tests at SWMU 94.

Figure 4A-3
Photograph of Portable Pan

Burn pits were excavated and lined with black polyethylene or polyvinyl chloride (PVC) film, water was placed in the pit, and a layer of jet fuel composition 4 (JP-4) fuel was placed on the water (Littrel February 1969, Foy April 1971, Stravasnik September 1972, Larson and Palmieri August 1994b, Jercinovic et al. November 1994, Palmieri November 1994a). Stands or frames that held the test devices were constructed of steel, and sometimes platinum strips were used to separate the test device from the steel frame (in order to avoid reaction between the test device and the frame) or to suspend the device above the pool (Young et al. February 1994, Littrel February 1969, Foy April 1971, Clark December 1970, Walkington April 1973). When thermocouples and other electronic wiring were used to monitor the burn tests, the control wiring was insulated with ceramic and placed on a ceramic-insulated steel frame (Author [unk] June 1993). In some tests, a metal *chimney* was placed over the pool prior to igniting the fuel to eliminate wind effects and control the fire (Jercinovic et al. November 1994).

To control the burn time, the thickness of the JP-4 fuel layer was accurately measured before the test was conducted (Foy April 1971, Walkington April 1973, Stravasnik September 1972). The test pits may have leaked water and fuel through holes in the plastic (Larson and Palmieri August 1994b) because flames melted exposed parts of the black plastic liner. The pits were left uncovered upon completion of these burn tests (Author [unk] June 1993), and in general, cleanup was not performed (Young et al. February 1994). At the conclusion of the test, the remaining water and fuel were left to evaporate or infiltrate (Larson E. and Palmieri D. August 1994b, Jercinovic et al. November 1994, Palmieri November 1994a).

The exact locations of the burn pits used during testing cannot be determined, because grading and construction activities related to SWMU 94 erased all evidence of the depressions or features associated with the test locations. However, Based upon technical reports (Littrel February 1969, Walkington April 1973, Stravasnik September 1972) and interpretation of historical aerial photographs (SNL/NM August 1994), burn pits were excavated in the area designated SWMU 65C.

Materials that may have been used in the burn pit tests include JP-4 fuel, diesel fuel, rocket propellant, ammonium nitrate slurry, trinitrotoluene (TNT), chromel/alumel thermocouples, steel shipping containers, Celotex™ insulation, polyethylene containers, PVC, Dy-Kem steel-blue layout dye, argon, and ceramic insulation (Young et al. February 1994, Moore and Luna February 1982, Littrel February 1969, Foy April 1971, Clark December 1970, Walkington April 1973, Stravasnik September 1972). Details on these testing events are given below.

A.2.1 Cloudmaker Tests and Other Ammonium Nitrate Tests

In January 1969, three burn tests were conducted in pits at SWMU 65C to determine the effect of a fuel fire on an ammonium nitrate slurry bomb, referred to as the Cloudmaker (Young et al. February 1994, Littrel February 1969). The slurry mixture contained 50 percent ammonium nitrate, 35 percent aluminum powder, 14 percent water, and 1 percent gums and stabilizers (Littrel February 1969). The first two tests were conducted on the TNT booster charge that was used to detonate the ammonium nitrate slurry; the third test involved detonating the ammonium nitrate. The Cloudmaker burn test used 8,100 lb of slurry (equivalent to 10,500 lb of TNT) that consisted of 50 percent ammonium nitrate (Littrel February 1969) and was detonated 1,000 feet southeast of Bunker 9830. When actual detonation occurred in the third Cloudmaker test, the explosion scattered dust and shrapnel as far as 800 feet in all directions (Littrel February 1969).

One interview record states that additional ammonium nitrate tests were conducted using 15,000-lb ammonium nitrate slurry bombs that were intended to be representative of a portion of a 35,000-lb bomb (Karas June 1993). The purpose of these tests was to determine whether a Composition-4 (C-4) charge would successfully detonate ammonium nitrate. Detonations were successful in tests that were completed in 1969 and 1970 (Karas June 1993). An additional 15,000-lb ammonium nitrate slurry bomb was unexpectedly detonated during a burn test when steam pressure from the slurry built up, popped the relief valve, and detonated the ammonium nitrate (Karas June 1993, Larson and Palmieri August 1994b). Although a specific location for the tests was not given, it is reported that large HE tests were conducted at SWMU 65C near the area now occupied by the LOBP (Palmieri December 1994b). This is in the same general vicinity as the 1969 Cloudmaker test.

A.2.2 Liquid Fuel Fire and Solid Rocket Propellant Burn Tests on Pioneer Capsules

Burn tests in excavated pits were conducted on Pioneer capsules in 1970 to determine whether the capsule could survive a launch abort (Foy April 1971). The test sequence, carried out at SWMU 65C, consisted of two liquid-fuel-fire tests and three solid rocket propellant tests (two direct-fire tests and one proximity test) and ended with two liquid-fuel-fire tests (Foy April 1971). Rocket propellant tests designated as direct fire involved thermocouples that were directly attached to the propellant block, whereas the proximity test had the thermocouple positioned between two propellant blocks. Approximately 1,400 gallons of JP-4 fuel was used in each liquid fuel test, and one to two 12- by 12- by 18-inch (in.) block(s) of TP-H-3062 rocket propellant was used in each solid propellant fire test (Foy April 1971). In the liquid-fuel-fire tests, Pioneer capsules P-12 and P-19 were preheated to 1,800 degrees Fahrenheit (°F), and P-9 and P-15 were preheated to 1,300°F in an argon atmosphere oven prior to being placed in the fuel fire (Foy April 1971, Clark December 1970). The test reports do not describe the materials used in the construction of the Pioneer capsules.

A.2.3 Plutonium Shipping Container Tests

Several JP-4 fuel fire tests of shipping containers designed to carry plutonium were conducted in excavated pits in 1972. Department of Transportation (DOT) Class II plutonium containers (DOT-6M, DOT-SP5795, and L-10) were tested in a 1,800°F fire for one hour. To assess the integrity of the containers, polyethylene bottles were filled with a Dy-Kem steel-blue layout dye and alcohol solution, were wrapped in Celotex™ insulation, and were placed inside each container. The DOT-6M container failed to retain the solution, but all of the others did retain the solution. A photo included within a test report (Stravasnik September 1972) shows that the location of the test is in the historic arroyo channel located at SWMU 65C. This location conforms to all other known burn pit test locations that were conducted for the Cloudmaker and TC-708 Emergency Denial Device.

A.2.4 TC-708 Emergency Denial Device Tests

In February 1973 a diesel-fuel fire test on a TC-708 Emergency Denial Device was conducted at SWMU 65C in an excavated pit located approximately 1,000 feet southeast of Bunker 9830 (Walkington April 1973). The test report gave no specific information on the test materials or on the use or purpose of the device, but it noted that six chromel/alumel thermocouples (Type K) were attached to the unit and that the unit melted after approximately 4 minutes (min) into the test (Walkington April 1973).

A.3 MISCELLANEOUS BURN TESTS (NONPETROLEUM-FUEL-FIRE)

Miscellaneous burn tests conducted at SWMU 65 include wood crib tests, liquid oxygen torch tests, and rocket propellant tests (Palmieri December 1994d, Hickox and Abitz December 1994). The tests, which began in 1984 and ended in 1993, occurred at SWMU 65B and SWMU 65D. Materials that may have been used in the miscellaneous burn tests include rocket propellant, HE detonators, propane, empty weapon casings, liquid oxygen, aluminum powder, nitrogen gas, graphite, and steel rods (Hickox and Abitz December 1994). The following paragraphs provide additional details on these tests.

A.3.1 Wood Crib Fire Tests

Seventeen wood crib tests were conducted at SWMU 65B from September 1988 to September 1989. These tests consisted of cross stacking 1- by 4-in. by 6-foot-long planks to a height of about 8 feet to make a 6- by 6- by 8-foot stack or crib. A suitcase containing detonators and HE components was placed in the crib and the wood was ignited. The wood fire induced an explosion of the detonators when the HE critical temperature was reached. The purpose of the test was to evaluate the performance of the suitcase by recording the distance that the ejected components traveled. All components had to stay within a specified radius for the suitcase to pass the test. The composition of the components is unknown, but all component parts are believed to have been recovered following the test (Hickox and Abitz December 1994).

A.3.2 Liquid Oxygen Torch Tests

Nineteen liquid oxygen torch tests were conducted at SWMU 65B in 1984 and 1985 to determine whether a torch could simulate a controlled rocket propellant fire (Hickox and Abitz December 1994). The liquid oxygen torch consisted of a nozzle welded to a steel frame. Liquid oxygen and aluminum powder were fed to the nozzle via gas lines and valves with a high-pressure nitrogen gas reservoir. Propane and gaseous oxygen were used as the pilot light system with some testing of the torch involving graphite or steel rods. The only burn product associated with operating the torch was aluminum oxide. Design and proofing tests were conducted in SWMU 65B. The nose cones of reentry vehicles were eventually tested with the torch at Thunder Range (Hickox and Abitz December 1994).

A.3.3 Rocket Propellant Tests

Ten fire tests with rocket propellant and simulated weapons were conducted in 1983 and 1984 at several locations within SWMU 65B and SWMU 65D (Palmieri December 1994d, 65-76). A PII propellant burn rate test was conducted at Location A (Figure 4A-2) on January 12, 1984. This test measured the uninhibited burn rate of the propellant at 6 in. per min, and the inhibited burn rate was measured at 3 in. per min. Propellant used for the inhibited burn rate test contained axle grease to reduce the burn rate of the propellant. Three burn tests with the W-85 weapon casing (no HE present) were conducted in February and March 1984 at Location B

(Figure 4A-2). These tests were conducted to investigate the burn time required to rupture the aluminum weapon casing. Three propellant burn tests were conducted at Location C (Figure 4A-2) with the W-88 weapon casing in May and July of 1987. Specific notes on test results are absent from the test log. One rocket propellant test involving 375 lb of rocket propellant used in the SRAM II missile was conducted at Location C (Figure 4A-2) in August 1993. The test log notes that industrial hygiene personnel were present to monitor for hydrochloric acid. In August and September 1986, two propellant burn tests were conducted at Location D (Figure 4A-2) using the W-31/Y1-3 and W-87/LTU-7 weapon/propellant systems. The test log for the W-31/Y1-3 burn test noted that one propellant cylinder detonated 2 min into the test. A comprehensive list of materials used in these tests was not provided in the test log.

A.4 CONE TESTS

The Conical Containment (CON-CON) Unit was constructed between late 1981 and early 1982 (SNL/NM August 1994) for tests that investigated the penetration of a radioactive tracer (i.e., sodium-24 and uranium dioxide) into unconsolidated overburden. A series of 22 tests were conducted between March 1982 and March 1984 (SNL/NM August 1986, Church March 1982, Palmieri November 1994a). The CON-CON Unit was part of SNL/NM's Nuclear Emergency Search Team project, which studied mitigation techniques for reducing the consequences of an accidental detonation of a nuclear materials explosives dispersal device (Church March 1982).

In constructing the CON-CON Unit, a trench and depression were excavated to a depth of approximately 10 feet, a width of 14.5 feet, and a length of 40 feet (Church March 1982, Jercinovic et al. November 1994). A corrugated culvert was laid down in the excavation (Jercinovic et al. November 1994), and a 17-foot-high steel cone with a base diameter of 6 feet was placed apex down into a port in the center of the culvert (Church March 1982). An 11-foot-long vertical steel cylindrical diagnostic containment section with a diameter of 6 feet was mounted on top of the cone, and the excavation was backfilled to the top of the cone. The southern part of the culvert was left open to allow access for placing the test units at the apex of the cone (Church March 1982, Jercinovic et al. November 1994). A shallow, open trench (30 by 350 feet) extended southward from the culvert opening (SNL/NM August 1994).

The apex of the cone was the location for the C-4 explosives and sodium-24 tracer. The sand or foam overburden material being tested for penetrability was placed over the sodium-24 tracer (Church March 1982, Jercinovic et al. November 1994). The diagnostic containment section was placed above the cone and was equipped with valves to pull air samples, high efficiency particulate air filters, and camera parts (Palmieri December 1994c). The diagnostic containment section contained and measured aerosol and particle dispersion via the activity of the sodium-24 isotope (Palmieri November 1994a).

A total of 22 tests were conducted: one with uranium dioxide powder, seven with sodium-24 tracer (with a half-life of 15 hours (hr) [General Electric Company 1989]), two misfires, and twelve involving instrument calibration, facility seal integrity, and firing system effectiveness. In the tracer tests, a 50- to 150-gram HE charge of C-4 was placed in the cone apex with the sodium-24 tracer (no more than 10 microcuries) positioned directly above the HE (SNL/NM August 1986, Church March 1982, Jercinovic et al. November 1994). Aerosol generated from the C-4 detonation was monitored for radioactivity in the diagnostic containment section (Palmieri November 1994a, Palmieri November 1994b, Palmieri December 1994c).

The CON-CON Unit was dismantled in 1988 (Palmieri and Larson October 1994) and the Smoke Emissions Reduction Facility (SMERF) was built in the same location (Jercinovic et al. November 1994). The trench that remained from the CON-CON Unit dismantling was widened to accommodate the SMERF (SNL/NM August 1994, Jercinovic et al. November 1994).

A.5 TORCH-ACTIVATED BURN SYSTEM (TABS) TESTS

The TABS test program was conducted from February 1975 to February 1979 to investigate the deflagration-to-detonation transition of HE in weapons, weapon pit damage, dispersal of toxic pit materials, and thermal modeling (Kurowski January 1979). This program consisted of 12 tests with 14 test units that used six different weapon types (B-54, B-57, B-53, B-61, W-44, and W-48). Torches were mounted to the weapons test unit and ignited to determine whether the torch could successfully burn through the weapons casing and ignite and burn the enclosed HE without detonating the weapons. Successful burning was accomplished in all weapons types except one, where three of the five test units detonated. The unsuccessfully tested weapon was not identified. Materials that were involved in the TABS tests include HE, DU, beryllium, and aluminum (Kurowski January 1979, Larson August 1994).

The TABS test report (Kurowski January 1979) does not identify the location of the individual TABS tests, with the exception of noting that Test V was conducted at the Coyote Test Field on July 28, 1978. Based upon information obtained from Environmental Restoration interview records (Jercinovic et al. November 1994, Larson August 1994, Palmieri December 1994e), it is known that four of the fourteen tests were conducted at SWMU 60, Bunker Site, and two tests were conducted at SWMU 65. At SWMU 65, one test (Test VI) detonated in the trench of the Bomb Burner Unit (TABS test Location B; Figure 4A-2), and one test took place near the camera bunker (TABS test Location A, SWMU 65B; Figure 4A-2). The TABS test Location B is included with SWMU 94C. The remaining eight tests took place at three locations in Technical Area 2 (Palmieri December 1994e). All of the tests were recorded by movie and still cameras (Kurowski January 1979).

In the TABS tests, a torch was mounted on the weapons component and ignited with a hot-wire device. Torch burn time varied from 10 to 27 seconds (sec) to allow the torch to cut through the weapons casing and ignite the HE (Kurowski January 1979). HE burn time varied from 4 to 7.8 min in the successful burn tests and varied from 11 to 47 sec in the two tests that detonated (Kurowski January 1979). Residue in the weapons and the weapons components continued to burn for approximately 3 to 80 min after the HE was consumed (Kurowski January 1979). For the successful burn test at SWMU 65B, postburn examination of the weapons indicated that the HE was completely consumed (Kurowski January 1979). The weapons in Test VI (TABS Test Location B, Bomb Burner trench, SWMU 94C) detonated 47 sec into the test, dispersing DU fragments that ignited a few small fires northeast of the detonation area (Jercinovic et al. November 1994, Larson August 1994, Larson and Palmieri August 1994c). There is no discussion on the dispersal of pit material in the test report (Kurowski January 1979), and test personnel could not discuss the information because of its classified nature (Palmieri December 1994e).

After a TABS test was performed, Sandia National Laboratories/New Mexico health physics personnel conducted radiation surveys of the site (Larson August 1994). All uncontaminated (i.e., nonradioactive) debris was taken to the scrap yard located in the northwestern corner of the site, and debris contaminated with radioactivity was transported to the Mixed Waste Landfill in Technical Area 3.

A.6 SLOW-HEAT TESTS

Slow-heat tests were conducted between 1982 and 1986 in the general area between the camera bunker and the CON-CON Unit in the primary detonation area and near-field dispersion area (SWMU 65B and SWMU 65D) (Jercinovic et al. November 1994, Palmieri November 1994a). The 11 recorded tests investigated the quantity of HE consumed by detonations induced by slowly heating the test unit with electrical current passed through heat tape (Luna October 1985, Luna June 1983, Moore and Luna February 1982, SNL/NM August 1986). Materials that were involved in the slow-heat tests include HE, steel test vessels, chromel/alumel thermocouples, lead tape, plywood boxes, and vermiculite packaging.

A three-sided concrete block bunker was constructed for the slow-heat tests, and a plywood box was placed in the center (Jercinovic et al. November 1994). The test unit consisted of an 8- or 10-in. steel containment vessel rated at 2,000 to 40,000 lb per square inch that held 6 to 6.5 lb of HE (Luna October 1985, Luna June 1983, Moore and Luna February 1982). Heat tape was wrapped around the containment vessel, and chromel/alumel thermocouples (Type K) were secured to the test vessel with lead (Luna October 1985) or aluminum (Luna June 1983) tape. The test vessel was then sealed in the plywood shipping container and surrounded with vermiculite (Luna October 1985, Luna June 1983, Moore and Luna February 1982). Current was passed through the heat tape to produce a nominal heating rate of 50 degrees Celsius per hr, and the test unit was heated for 4 to 5 hr until the HE detonated (Luna October 1985, Luna June 1983, Moore and Luna February 1982). Vessel fragments and unexpended HE were picked up after completion of the tests (Luna October 1985, Luna June 1983). Undetonated explosives may have been turned over to Kirtland Air Force Base Explosive Ordnance Disposal (Martz September 1985). Because the purpose of the tests was to see how much HE was expended during a slow-heat detonation, unexpended HE was recovered for mass balance calculations (Jercinovic et al. November 1994).

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ANNEX 4-E
Risk Screening Assessment

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SWMU 65A: RISK SCREENING ASSESSMENT

I. Site Description and History

Solid Waste Management Unit (SWMU) 65A is a subunit of SWMU 65, which was identified as the Lurance Canyon Explosives Test Site (LCETS) and is located on U.S. Air Force land withdrawn from Bureau of Land Management and permitted to the U.S. Department of Energy (DOE) (SNL/NM July 1994a). This site is situated on the canyon floor alluvium in the upper reaches of the Lurance Canyon drainage. This drainage is surrounded by moderately steep sloping canyon walls and the immediate topographic relief around the site is over 500 feet. A 25- to 50-foot-wide road is cut on the hill slopes as a firebreak and encircles the site. The canyon floor at the site is isolated by the canyon walls except for the western drainage into the Arroyo del Coyote. Coyote Springs Road follows this drainage and is the main access into the Lurance Canyon.

SWMU 65 was used from the late 1960s to the early 1990s for explosives testing. The location of SWMU 65 is coincident with SWMU 94 (Lurance Canyon Burn Site [LCBS]), which is actively used for testing fire survivability of transportation equipment, storage equipment, simulated weapons, and satellite components. SWMU 94 activities began in the mid-1970s and continue to the present.

Based upon the location of detonations and the types of tests conducted at SWMU 65, the site has been divided into five subunits: SWMU 65A (Small Debris Mound), SWMU 65B (Primary Detonation Area), SWMU 65C (Secondary Detonation Area), SWMU 65D (Near-Field Dispersion Area), and SWMU 65E (Far-Field Dispersion Area). The SWMU 65 subunits are each addressed in separate risk screening assessments. SWMU 65E is described in Chapter 6.0 of this no further action (NFA) proposal. SWMUs 65B, 65C, and 65D will be addressed in future NFA proposals.

SWMU 65A is a small soil-covered concrete bunker approximately 6 feet high by 7 feet wide by 14 feet long (Freshour May 1998) that lies on the southeast rim of the Oil Surface Impoundment (SWMU 13) at a mean elevation of 6,363 feet above sea level (SNL/NM April 1995). The interior of the bunker is coated with an approximately 1-foot-thick layer of foam on all surfaces. Toward the back of the bunker, the concrete floor contains no foam (Freshour March 1998). Springs are embedded in the foam and the foam appears to have burned. Interviewees identified the small debris mound on the edge of the Oil Surface Impoundment as a small concrete bunker covered with soil (Larson and Palmieri October 1994, Palmieri November 1994).

Historical published information regarding the hydrogeology of the Lurance Canyon has been summarized in the "RCRA [Resource Conservation and Recovery Act] Facility Investigation (RFI) Work Plan for the Operable Unit [OU] 1333, Canyons Test Area (SNL/NM September 1995). Since that time, additional bedrock wells and alluvial piezometers have been installed in the Lurance Canyon and data collected from the new bedrock wells have supported the hydrologic model of semiconfined to confined groundwater conditions at a depth of approximately 222 feet below ground surface (bgs) beneath the Lurance Canyon SWMUs. The data collected from the alluvial piezometers support the absence of alluvial groundwater.

Hydrologic data have been based upon the Burn Site Well, CYN-MW1D, 12AUP01 (piezometer), and CYN-MW2S (piezometer). In summary, the groundwater beneath the LCETS occurs at depths of at least 222 feet bgs under semiconfined to confined conditions in fractured metamorphic rock. There has been no record to date of shallow groundwater occurring in the alluvium overlying the bedrock.

Historical aerial photographs indicate that construction of the LCETS had begun by October 1967; by 1971 the test site was in full operation, and several structures were visible (SNL/NM August 1994). A firebreak road was constructed around the site between 1967 and mid-1971 to protect the surrounding area from accidental fires caused by the detonation of explosives or by burn testing (SNL/NM August 1994).

Interviews with former Sandia National Laboratories/New Mexico (SNL/NM) personnel also aided in reconstructing historical operations at SWMU 65. SWMU 65 was established between 1967 and 1969 (Larson and Palmieri August 1994a, Palmieri December 1994a) as an explosives test area designed with a 10,000-foot dispersion radius that provided an adequate buffer for open detonations of up to 10,000 pounds of high explosives (HE) (Gaither et al. May 1993, Author [unk] Date [unk], Larson and Palmieri August 1994a, Larson and Palmieri August 1994b). The majority of the open-detonation explosives tests were conducted between 1967 and 1975. All open-detonation explosives tests were concluded by the early 1980s (Larson and Palmieri August 1994b). The frequency of testing at SWMU 65 between 1968 and 1980 has been estimated at 20 tests per year (Gaither et al. May 1993, Author [unk] Date [unk]). Based upon information provided in the interviews, open-detonation explosives tests were conducted within the primary (SWMU 65B) and secondary (SWMU 65C) detonation areas.

In addition to open-detonation explosives tests, fuel-fire burn tests of test units containing explosives were conducted at SWMU 65 in excavated pits from 1969 to 1979 (Littrell February 1969, Jercinovic et al. November 1994). Portable pans and engineered burn structures completely replaced burn pit tests by 1979 (Jercinovic et al. November 1994). From the mid-1970s, a variety of nonpetroleum-fuel-fire burn tests were conducted. These tests included slow-heat detonations (1983 to 1986) (Luna June 1983, Luna October 1985, Moore and Luna February 1982), Torch-Activated Burn System tests (1975 to 1977) (Kurowski January 1979, Jercinovic et al. November 1994, Larson August 1994, rocket propellant burn tests (1984 to 1993) (Palmieri December 1994b, Hickox and Abitz December 1994), liquid oxygen torch tests (1984 to 1985) (Hickox and Abitz December 1994), and wood crib fire tests (1988 to 1989) (Hickox and Abitz December 1994). Small explosives testing was also conducted in the former Conical Containment Unit in 1982 (SNL/NM August 1986, Church March 1982).

A radiological voluntary corrective measure (VCM) was completed in October 1996 at the site to remove all point source and area source gamma radiation anomalies (SNL/NM September 1997).

II. Data Quality Objectives

The confirmatory sampling conducted at SWMU 65A was designed to collect adequate samples in order to:

- Determine whether hazardous waste or hazardous constituents have been released at the site
- Characterize the nature and extent of any releases
- Provide sufficient quality of analytical data to support risk screening assessments

Table 1 summarizes the sample location design for SWMU 65A (the Small Debris Mound). The primary source of constituents of concern (COCs) at SWMU 65A is metal weapons casings and HE used in a single detonation propagation test conducted at a small concrete bunker. The test was originally thought to have destroyed the bunker, leaving only a small soil/debris mound. However, initial sampling activities conducted in May 1996 revealed that the bunker was intact. Because initial sampling activities were performed outside the bunker, additional sampling was conducted in March and May 1998 to investigate potential contamination inside the bunker.

The number and location of the samples initially collected outside the bunker depended upon the completeness of historical information. However, discovery of the intact bunker during the initial sampling activities suggested that contamination would have been contained inside the bunker. Additional samples were, therefore, collected from the interior of the bunker. Soil on the bunker floor most likely was not present during testing but accumulated inside the bunker as it was covered and filled in after testing. Any contamination from the testing, if present, should have been homogeneously distributed inside the bunker because of the nature of explosives testing (SNL/NM March 1998). As a result, sampling locations inside the bunker were judgmental based upon the extent of the reach of the backhoe that was used to clear soil away for the bunker entrance.

The bunker and all soil contained in the bunker were removed from the site in March 1999 during a voluntary corrective action, and confirmatory soil samples were collected from the ground surface at the former location of the bunker. The bunker and soil were disposed of as solid waste in the Kirtland Air Force Base landfill (permitted for RCRA Subtitle D Construction and Demolition Solid Waste). As a result, only the analytical data pertinent to environmental samples surrounding the bunker (e.g., soils) and beneath the former location of the bunker are presented in this risk screening assessment. Analytical results presented in Section 5.4.4.3 of the NFA proposal indicate the material comprising the bunker neither contains RCRA hazardous waste nor exhibits the characteristics of RCRA hazardous waste. These analytical data relate only to waste characterization samples (e.g., debris) and are not used to support this screening risk assessment.

Table 2 summarizes the analytical methods and data quality requirements necessary (1) to provide adequate characterization of hazardous waste or hazardous constituents associated with the HE and metals used in propagation test conducted at the site and (2) to support risk screening assessments.

A total of 13 locations were sampled inside, outside, and at the former location of the bunker at SWMU 65A. Soil samples collected in May 1996 from outside the bunker were analyzed by SNL/NM on-site laboratories. Twenty percent of those samples were sent off site for verification analysis for both RCRA metal plus beryllium and HE. All soil samples collected in March 1998 from inside the bunker were analyzed off site for RCRA metals plus beryllium, HE, and gross alpha/gross beta activities. SNL/NM on-site laboratories also analyzed several

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 65A Sampling Phases	Potential COC Source	Number of Sampling Locations	Sample Density	Sampling Location Rationale
Outside of bunker, May 1996	Dispersed HE and metals from Propagation Test	6	Two soil samples collected from each of three trenches cut along the closed sides of the bunker.	To assess potential release of COCs outside the bunker, sample locations included the surface (0 to 6 inches) and subsurface (6 to 12 inches) at the mid-point of each trench cut adjacent to the closed sides of the bunker.
Inside bunker, March1998	Residual HE and metals from Propagation Test remaining inside bunker	5	Three samples collected from soil that accumulated on bunker floor. Two debris samples collected from wall and ceiling of bunker.	Waste characterization of soil on the bunker floor. Soil sample locations included the surface at the entrance, the surface at the extent of backhoe reach into the bunker, and floor level at the extent of backhoe reach into the bunker. Waste characterization of the bunker concrete insulation. Judgmental sample locations included the insulation attached to the bunker walls and ceiling.
Former location of bunker, March 1999	Potential release through the bunker floor of residual HE and metals from Propagation Test remaining inside bunker	2	Two samples and one duplicate collected from ground surface at former location of bunker after removal.	To assess potential release of COCs under the bunker, samples were collected at two locations from the surface (0 to 6 inches) at the former location of the bunker.

COC = Constituent of concern.
HE = High explosive(s).
SWMU = Solid Waste Management Unit.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	ER Chemistry Laboratory Department 6133 SNL/NM	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM	Core Laboratories Inc., Aurora, Colorado	Lockheed Analytical Services Las Vegas, Nevada	GEL Laboratories Charleston, South Carolina
RCRA metals plus beryllium EPA Method 6010/7000[a]	Level 3	6 samples	NA	3 samples 2 samples (off-site internal duplicates)	1 sample (off-site duplicate)	2 samples
HE compounds EPA Method 8330[a] (or equivalent)	Level 3	6 samples	NA	3 samples 1 sample (off-site internal duplicate)	1 samples (off-site duplicate)	2 samples
Gamma spectroscopy	Level 2	NA	3 samples prior to VCA and 2 samples during VCA	NA	NA	NA
Gross alpha/ gross beta EPA Method 900.0[a]	Level 3	NA	NA	5 samples 2 samples (off-site internal duplicates)	NA	NA
Total uranium	Level 3	NA	NA	NA	NA	2 samples

[a]EPA November 1986.

EPA = U.S. Environmental Protection Agency.
ER = Environmental restoration.
GEL = General Engineering Laboratories.
HE = High explosive(s).
NA = Not applicable.
RCRA = Resource Conservation and Recovery Act.
SNL/NM = Sandia National Laboratories/New Mexico.
VCA = Voluntary Corrective Action.

samples for radionuclides using gamma spectroscopy to permit the transport of samples to off-site laboratories. All samples collected from the former location of the bunker after it had been removed in March 1999 were analyzed off-site for RCRA metals plus beryllium, HE, and total uranium.

The minimum detection limits (MDL) for all on-site analyses of total metals exceeded the background concentration limits for arsenic, cadmium, mercury, selenium, and silver. However, the MDL for on-site analysis of mercury was very close to the background concentration limit. The on-site analysis MDL for mercury was 0.06 milligram (mg) per kilogram (/kg) as compared to the background concentration limit of 0.055 mg/kg. The off-site laboratories provided a lower MDL for metals analyses, with only a single exception. The MDL used by Lockheed Analytical Services for the analysis of mercury was 0.10 mg/kg.

All gamma spectroscopy data were review by SNL/NM Department 7713 (Radiation Protection Sample Diagnostic [RPSD] Laboratory) according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). On- and off-site laboratory results obtained for the samples collected in May 1996 were reviewed and verified/validated according to "Data Verification/Validation Level 2-DV-2" in Attachment B of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). In addition, all off-site laboratory results obtained for the samples collected in March 1998 and 1999, were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). The reviews confirmed that the data are acceptable for use in the NFA proposal for SWMU 65A. The data quality objectives (DQO) for SWMU 65A have been met.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 65A was based upon an initial conceptual model validated with confirmatory sampling at the site. The initial conceptual model was developed from historical background information including site inspections, personal interviews, historical photographs, and radiological surveys. The DQOs contained in the work plan for OU 1333 (SNL/NM September 1995) and Field Implementation Plan (FIP) addendum to the work plan (SNL/NM March 1998) identified the sample locations, sample density, sample depth, and analytical requirements. The sample data collected were subsequently used to develop the final conceptual model for SWMU 65A, which is presented in Section 5.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination is described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 65A was determined with analytical testing of soil media and by the potential for degradation of relevant COCs (Section V). The analytical requirements included RCRA metals plus beryllium to characterize nonradiological inorganic constituents released at the site. HE analyses were performed to characterize any potential explosives materials that may have not reacted during the detonation(s). Gamma spectroscopy, gross alpha/gross beta, and total uranium analyses were also performed to verify that no radioactive materials remain at the site. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with the historical activities at SWMU 65A.

III.3 Rate of Contaminant Migration

SWMU 65A is an inactive site, and therefore, all primary sources of COCs (propagation tests involving metals and HE) have been eliminated. The bunker and all soil contained inside the bunker have been removed from the site. As a result, only secondary sources of COCs in the soil surrounding the former bunker remain at SWMU 65A. The rate of COC migration is dependent predominantly upon site meteorological and surface hydrologic processes as described in Section V. Data available from SNL/NM's Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the Kirtland Air Force Base (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of the migration of COCs at SWMU 65A.

III.4 Extent of Contamination

Surface soil samples were collected from outside the bunker and from the former location of the bunker at SWMU 65A. Soil samples were also collected from outside the bunker within three trenches cut along the closed sides of the bunker. Each sample from outside the bunker was approximately 2 to 3 feet from the edge of the bunker. Three surface soil samples (0 to 6 inches) were collected from outside the bunker from the approximate middle of the three trenches. Because soil had accumulated inside the bunker as it was covered after the propagation test, soil samples were collected from three locations inside the bunker for waste characterization: the entrance, the surface at the extent of the reach of the backhoe into the bunker, and the floor level at the extent of the reach of the backhoe into the bunker. These sample locations are deemed appropriate to determine the lateral extent of COC migration.

The sample density inside the bunker was based upon waste characterization requirements. Based upon the relatively small size of the bunker (approximately 7 feet wide by 6 feet high by 14 feet long), one sample was collected at the entrance and two samples were collected at the approximate center (i.e., extent of backhoe reach). At the approximate center of the bunker one sample was collected from the surface and one sample was collected from directly above the concrete bunker floor. The sample density from the soil covering the outside of the bunker was based upon one surface sample and one subsurface sample on each side of the bunker. The sample distance from the edge of the bunker was based upon the extent of the soil mound covering the bunker. The sample density at the former location of the bunker was based upon the relatively small size of the bunker (approximately 7 feet wide by 6 feet high by 14 feet long), one sample was collected at each end of the former location of the bunker. The number of samples was deemed sufficient to establish the presence of residual COCs in the site.

Because of the relatively low solubility of most metals and organic compounds, the limited precipitation, and high evapotranspiration, the rate of vertical migration of COCs from residual soil is expected to be extremely low. Because the bunker was constructed above grade, and soil was mounded over the bunker surface, three subsurface soil samples were collected from the middle of the three trenches at approximately 6 to 12 inches below the mound surface. There is no historical information that any subsurface disturbance, testing, or disposal ever occurred at the site that could have caused the soil covering the bunker to mix with the undisturbed soil surface beneath the bunker. Therefore, the samples collected from SWMU 65A are considered representative of the media potentially affected by site activities and are sufficient to determine the vertical extent of COCs migration.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, rate, and extent of contamination.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The SWMU 65A NFA proposal describes the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across the site. Generally, COCs evaluated in this risk assessment include all detected organics and radiological COCs and all inorganic COCs for which the samples were analyzed. If the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics that were not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997, Zamorski December 1997) was selected to provide the background screen listed in Tables 3 and 4. Human health nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 3) (IT July 1994).

Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. Nonradiological COCs that were evaluated in this risk assessment were limited to inorganics because all organic samples yielded nondetections.

Table 3 lists nonradiological COCs for human health and ecological risk assessment at SWMU 65A. Table 4 lists radiological COCs. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997, Zamorski December 1997). Sections VI.4, VII.2, and VII.3 discuss Tables 3 and 4.

V. Fate and Transport

The primary release of COCs at SWMU 65A was to surface and subsurface soil resulting from the removal of a partially buried bunker. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Both wind and surface-water runoff can transport surface soil particles from the site, potentially carrying COCs with them. However, because the site is situated within the Lurance Canyon in the Manzanita Mountains and is within woodland vegetation, it is protected from strong winds at the ground surface. Therefore, wind is probably not a significant transport mechanism for surface soils.

Water at SWMU 65A is received as precipitation (rain or occasionally snow) that will either infiltrate or form runoff. Infiltration at the site is enhanced by the coarse texture of the canyon soils (Tesajo-Millett stony sandy loam [USDA June 1977]), but the slopes at this site will probably produce runoff during intense rainfall events and during extended rainfall periods when soils are near saturation from previous rainfall. Surface runoff is to the ephemeral drainage, which is a tributary to the Arroyo del Coyote in the lower part of the canyon. Runoff could carry soil particles with adsorbed COCs. The distance of transport will depend upon the size of the particle and the velocity of the water. Because of the moderately steep slopes on and near the site and the tendency for precipitation to be received as intense downpours during the summer months, the transport of surface soil particles by runoff could be significant.

Table 3
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 65A with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Is COC a Bioaccumulator?[b] (BCF>40, Log K_{ow}>4)	Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	13[d]	9.8	**No**	44[e]	NA	**Yes**	0.5	**No**
Barium	250	246	**No**	170[f]	NA	**Yes**	6000	Yes
Beryllium	0.78 J	0.75	**No**	19[e]	NA	No	0.2	**No**
Cadmium	1.1[d]	0.64	**No**	64[e]	NA	**Yes**	80	Yes
Chromium, total[g]	15.3	18.8	Yes	16[e]	NA	No	400	Yes
Lead	11.4	18.9	Yes	49[e]	NA	**Yes**	--	--
Mercury	0.05[d]	0.055	Yes	5500[e]	NA	**Yes**	20	Yes
Selenium	25[d]	2.7	**No**	800[h]	NA	**Yes**	400	Yes
Silver	0.9[d]	<0.5	**No**	0.5[e]	NA	No	400	Yes

Note: **Bold** indicates the COCs that failed the background screening and/or the Supart S screening procedures and/or are bioaccumulators.
[a]From Zamorski (December 1997) Canyon Area Soils.
[b]From NMED (March 1998).
[c]From IT (July 1994).
[d]Parameter nondetect, concentration assumed to be one-half of detection limit.
[e]BCF and/or Log K_{ow} from Yanicak (March 1997).
[f]BCF from Neumann (1976).
[g]Assumed to be chromium VI for Subpart S screening procedure.
[h]BCF from Callahan et al. (1979).

BCF = Bioconcentration factor.
COC = Constituent of concern.
IT = IT Corporation.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 4
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 65A with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background[a] Screening Value?	BCF (maximum aquatic)	Is COC a Bioaccumulator?[b] (BCF>40)
Cs-137	0.042 (ND)	0.515	Yes	3000[c]	**Yes**
Th-232	0.87 (ND)	1.03	Yes	3000[d]	No[e]
U-234[f]	0.20	2.31	Yes	900[d]	**Yes**
U-235	0.02[g]	0.16	Yes	900[d]	**Yes**
U-238	1.56 (ND)	2.31	Yes	900[d]	**Yes**

Note: **Bold** indicates the COCs that failed the background screening procedure and/or are bioaccumulators.
[a]Dinwiddie September 1997, Southwest Test Area.
[b]NMED (March 1998).
[c]Whicker and Schultz (1982).
[d]Baker and Soldat 1992.
[e]Yanicak (March 1997).
[f]U-234 values were calculated using the U-238 concentration and assuming that the U-238 to U-239 ratio was equal to that detected during waste characterization of DU-contaminated soils generated during the radiological voluntary corrective measures project where U-234 = U238/8 (Miller June 1998).
[g]This sample yielded no detections, but the MDA exceeded the SNL/NM background value, so it would normally be considered in the risk analysis. However, historical data for the area indicate that the activity concentration of U-235 is 1/73 that of U-238. For the max U-238 activity concentration in this data set the U-235 activity concentration would be 0.02 pCi/g. The worst case residential exposure based on the MDA (0.22 Ci/g, not 0.06 pCi/g) for U-235 is 0.02 mrem/yr and 2E-6 rad/day to human and ecoreceptor. These dose rates are less than the benchmark of 15 mrem/yr and 0.1 rad/day to human and ecoreceptor, respectively.

BCF = Bioconcentration factor.
COC = Constituent of concern.
DU = Depleted uranium.
MDA = Minimum detectable activity.
ND = Not detected.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution could be leached farther into the subsurface soil with this percolation. None of the inorganic COCs at this site have a high potential for leaching into the soil. Based upon observations made during the installation of a piezometer in the arroyo channel (12AUP01) in SWMU 12A (about 1,200 feet north of SWMU 65A), the alluvium above the bedrock is about 58 feet thick. Moist soil was observed in the first 5 feet of alluvium, and the remaining 53 feet (to bedrock) were dry. The Burn Site Well (approximately 500 feet north of the site) did not encounter groundwater until 222 feet bgs. The groundwater level rose to a depth of 60 feet bgs, indicating semiconfined to confined groundwater conditions. Therefore, infiltration from the surface does not appear to be sufficient to contact groundwater in the area of the LCBS and it is highly unlikely that percolation will result in the leaching of COCs to groundwater.

Plant roots can take up COCs that are in the soil solution. These COCs could be transported to the aboveground tissues with the xylem stream and could then be consumed by herbivores or returned to the soil as litter. Aboveground litter could be transported by wind until it is consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores could pass through the gut and be returned to the soil in feces either at the site or far from the site, or they could be absorbed and held in tissues, metabolized, or later excreted. The herbivore could be eaten by a primary carnivore or scavenger and any constituents still held in the consumed tissues would repeat the sequence of absorption, metabolization, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain is dependent upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain. Although the site has been highly disturbed by the removal of the bunker, vegetation will be restored by reseeding and natural succession. Therefore, food chain uptake is a potential transport mechanism at this site.

Degradation of COCs at SWMU 65A could result from biotic or abiotic processes. Inorganic COCs at this site are elemental in form and are, therefore, not considered to be degradable. Transformations of inorganics could include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants).

Table 5 summarizes the fate and transport processes that could occur at SWMU 65A. COCs at this site include inorganics in surface and subsurface soil. Because the site is situated within the Lurance Canyon and is sheltered by surrounding slopes and woodland vegetation, significant transport of COCs by wind is unlikely; however, transport by surface-water runoff could be of greater significance because of the sloping terrain. Subsurface migration of COCs from leaching is not significant and COCs are highly unlikely to contact groundwater. For the inorganic COCs at this site, the potential for degradation and/or transformation is very low.

Table 5
Summary of Fate and Transport at SWMU 65A

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Low
Surface runoff	Yes	Moderate
Migration to groundwater	No	None
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low

VI. Human Health Risk Screening Assessment

VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that are not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index) and excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and the DOE to determine whether further evaluation, and potential site cleanup, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties regarding the contents of the previous steps are addressed.

VI.2 Step 1. Site Data

Section I provides the description and history for SWMU 65A. Section II compares the results to DQOs. Section III describes the determination of the nature, rate and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 65A has been designated a future land-use scenario of recreational (DOE et al. October 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because the potential exists to inhale dust. Soil ingestion is included for the radiological COCs as well. No contamination at depth was determined, and therefore no water pathways to the groundwater are considered. Depth to groundwater at SWMU 65A is approximately 222 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the recreational land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

This section discusses Step 3 and the two screening procedures. The first screening procedure compared the maximum COC concentration to the background screening level. The second screening procedure compared maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure was applied only to COCs that were not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of COCs were compared to the SNL/NM maximum screening level for this area (Dinwiddie September 1997, Zamorski December 1997). The SNL/NM maximum background concentration was selected to provide the background screen in Table 3 and was used to calculate risk attributable to background in Table 8. Only the COCs that were detected above their respective SNL/NM maximum background screening level or COCs that did not have a quantifiable background screening level were considered in further risk assessment analyses.

Radiological COCs that exceeded the SNL/NM background screening levels were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

Tables 3 and 4 present a comparison of SWMU 65A maximum COC concentrations to the SNL/NM maximum background values (Zamorski December 1997) for human health risk assessment. For the nonradiological COCs, six constituents were measured at maximum values greater than their respective background screening level. For the radiological COCs, no constituent was measured at an activity greater than its background. Therefore, no radiological risk assessment was performed.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface or near surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration of less than 1/10 the action level, then the site was judged to pose no significant health hazard to humans. If there were more than ten COCs, then the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA Region 6 (EPA 1996a). Two COCs that failed the background screen exceed 1/10 of the proposed Subpart S action level. Because of these COCs, the site fails the Subpart S screening criteria and a hazard quotient and excess cancer risk value must be calculated for all the COCs.

Radiological COCs do not have predetermined action levels analogous to proposed Subpart S levels, and therefore this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Table 6 (nonradiological) lists the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 6 were from the Integrated Risk Information System (IRIS) (EPA 1998a) and from the EPA Region 9 (EPA 1996b) electronic database.

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI value and the excess cancer risk, for both the potential nonradiological COCs and associated background for recreational and residential land uses

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in calculating intake values and subsequent HIs and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both recreational and residential land-use scenarios. The equations for nonradiological COCs are based upon the RAGS (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989) and other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989).

VI.6.2 Risk Characterization

Table 7 shows that for the SWMU 65A nonradiological COCs, the HI value is 0.00 and the excess cancer risk is 8E-7 for the designated recreational land-use scenario. The values listed in the table included exposure from soil ingestion and dust inhalation for the nonradiological COCs. Table 8 shows that assuming the maximum background concentrations of the SWMU 65A associated background constituents, the HI is 0.00 and the excess cancer risk is 6E-7 for the designated recreational land-use scenario.

Table 6
Toxicological Parameter Values for SWMU 65A Nonradiological COCs

COC Name	RfD_o (mg/kg-day)	Confidence[a]	RfD_{inh} (mg/kg-day)	Confidence[a]	SF_o (mg/kg-day)$^{-1}$	SF_{inh} (mg/kg-day)$^{-1}$	Cancer Class[b]
Arsenic	3E–4[c]	M	--	--	1.5E+0[c]	1.5E+1[c]	A
Barium	7E-2[c]	M	1.4E-4[d]	--	--	--	--
Beryllium	2E-3[c]	L to M	5.7E-6[c]	M	--	8.4E+0[c]	B1
Cadmium	5E-4[c]	H	5.7E-5[d]	--	--	6.3E+0[c]	B1
Selenium	5E–3[c]	H	--	--	--	--	D
Silver	5E–3[c]	L	--	--	--	--	D

[a]Confidence associated with IRIS (EPA 1998a) database values (L = low, M = medium, H = high).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a):

A = Human carcinogen.
B1 = Probable human carcinogen. Limited human data are available.
D = Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 1998a).
[d]Toxicological parameter values from EPA Region 9 (EPA 1996b).

COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
IRIS = Integrated Risk Information System.
mg/kg-day = Milligram(s) per kilogram day.
(mg/kg-day)$^{-1}$ = Per milligram per kilogram day.
RfD_{inh} = Inhalation chronic reference dose.
RfD_o = Oral chronic reference dose.
SF_{inh} = Inhalation slope factor.
SF_o = Oral slope factor.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 7
Risk Assessment Values for SWMU 65A Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Recreational Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	13[b]	0.00	8E-7	0.74	1E-4
Barium	250	0.00	--	0.04	--
Beryllium	0.78 J	0.00	2E-11	0.00	6E-10
Cadmium	1.1[b]	0.00	2E-11	0.9	6E-10
Selenium	25[b]	0.00	--	8.8	--
Silver	0.9[b]	0.00	--	0.04	--
TOTAL		**0.00**	**8E-7**	**11**	**1E-4**

[a]From EPA (1989).
[b]Parameter nondetect, concentration assumed to be 0.5 of detection limit.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
J = Estimated concentration
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 8
Risk Assessment Values for SWMU 65A Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Recreational Land- Use Scenario[b]		Residential Land- Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	9.8	0.00	6E-7	0.56	1E-4
Barium	246	0.00	--	0.04	--
Beryllium	0.75	0.00	2E-11	0.00	6E-10
Cadmium	0.64	0.00	1E-11	0.52	4E-10
Selenium	2.7	0.00	--	0.95	--
Silver	<0.5	--	--	--	--
TOTAL		**0.00**	**6E-7**	**2**	**1E-4**

[a]Zamorski (December 1997) Canyon Area Soils.
[b]From EPA (1989).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
-- = Information not available.

For the residential land-use scenario nonradiological COCs, the HI value increases to 11, and the excess cancer risk is 1E-4 (Table 7). The values in the table included exposure from soil ingestion, dust inhalation, and plant uptake. Although the EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 8 shows that for the SWMU 65A associated background constituents, the HI is 2 and the excess cancer risk is 1E-4.

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both the recreational land-use scenario (the designated land-use scenario for this site) and the residential land-use scenario.

For the recreational land-use scenario nonradiological COCs, the HI is 0.00 (much less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). The excess cancer risk is estimated at 8E-7. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by arsenic, which is a Class A carcinogen. Thus, the total excess cancer risk for this site is below the suggested acceptable risk value of 1E-6. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the recreational and the residential land-use scenarios. Assuming the recreational land-use scenario, for nonradiological COCs the HI is 0.00. The excess cancer risk is estimated at 6E-7. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituent that does not have a quantified background concentration (silver) is assumed to have an HQ of 0.00. There is no incremental HI. The incremental cancer risk is 2E-7 for the recreational land-use scenario. These incremental risk calculations indicate acceptable risk to human health from nonradiological COCs considering a recreational land-use scenario.

For nonradiological COCs in the residential land-use scenario, the calculated HI is 11, which is above the numerical guidance. The excess cancer risk is estimated at 1E-4. The excess cancer risk is driven by arsenic, beryllium, and cadmium, some of which are Class A or B carcinogens. Therefore, the total excess cancer risk for this site is above the suggested acceptable risk value of 1E-6. The HI for associated background for the residential land-use scenario is 2. The excess cancer risk is estimated at 1E-4. The incremental HI is 8.45 and the incremental cancer risk is 2E-10 for the residential land-use scenario. The incremental HI indicates a potentially significant contribution to human health risk from the COCs considering a residential land-use scenario.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 65A was based upon an initial conceptual model validated with confirmatory sampling conducted at the site. The confirmatory sampling was implemented in accordance with the RFI work plan for OU 1333 (SNL/NM September 1995) and the FIP addendum to the work plan (SNL/NM March 1998). The DQOs contained in the RFI work plan and FIP Addendum are appropriate for use in risk screening assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. Data quality was validated in accordance with SNL/NM procedures (SNL/NM July 1994b). Therefore, there is no uncertainty associated with the data quality used to perform the screening risk assessment at SWMU 65A.

Because of the location, history of the site, and future land-use (DOE et al. October 1995), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in performing the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that parameter values used in the calculations are conservative and that calculated intakes are probably overestimates. Maximum measured values of the concentrations of the COCs are used to provide conservative results.

Table 6 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from IRIS (EPA 1998a) and EPA Region 9 (EPA 1996b) databases. Where values are not provided, information is not available from the Health Effects Assessment Summary Tables (EPA 1997a), the IRIS (EPA 1998a), or the EPA regions (EPA 1996a, 1996b). Because of the conservative nature of the RME approach, the uncertainties in toxicological values are not expected to be sufficiently high to change the conclusion from the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the human health acceptable range for the recreational land-use scenario compared to established numerical guidance.

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

VI.9 Summary

SWMU 65A has identified COCs consisting of some inorganic compounds. Because of the location of the site, the designated recreational land-use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust inhalation for the chemical constituents. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs show that for the recreational land-use scenario the HI (0.00) is significantly less than EPA guidance values. The total excess cancer risk of 8E-7 is below the acceptable risk value provided by the NMED for a recreational land use (March 1998). There is no incremental HI and the incremental cancer risk s 2E-7 for the recreational land-use scenario. Incremental risk calculations indicate acceptable risk to human health for the recreational land-use scenario.

Because measured radiological activity concentrations were all below the appropriate SNL/NM background values, no radiological risk assessment was performed.

Uncertainties associated with the calculations are considered small relative to the conservativeness of risk assessment analysis. It is, therefore, concluded that this site poses insignificant risk to human health under the recreational land-use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 65A. A component of the NMED Risk-Based Decision Tree (March 1998) is to conduct an ecological screening assessment that corresponds with that presented in EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997b). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of the NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in the scoping assessment (Section VII.2 of this report), with the exception of DQOs which are reviewed in Section II of this document. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk management decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

Among the COPECs listed in Section IV (Tables 3 and 4), the following constituents within the 0- to 5-foot depth interval exceeded background concentrations:

- Arsenic
- Barium
- Beryllium
- Cadmium
- Selenium
- Silver

Of these, arsenic, cadmium, selenium, and silver had no detected values exceeding background concentrations (their inclusion in the risk assessment was based upon high detection limits). No organic analytes were detected in soil.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Arsenic
- Barium
- Cadmium
- Selenium

It should be noted, however, that as directed by the NMED (March 1998), bioaccumulation for inorganics is assessed exclusively based upon maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 5 (Section V), surface-water runoff is expected to be of moderate significance, while wind dispersion, food chain uptake, transformation, and degradation are expected to be of low significance for the COPECs at this site. Migration to groundwater is not anticipated.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways could be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure that ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure estimation—provides a quantitative estimate of potential exposure.
- Ecological effects evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Screening assessment scientific/management decision point—presents the decision to risk managers based upon the results of the screening assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM Environmental Restoration [ER] Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 65A is less than 0.1 acre in size and is located near the LCBS in the Manzanita Mountains. The site is largely disturbed because of the removal of the concrete bunker where the explosives test was performed. The surrounding natural habitat includes piñon/juniper woodland and riparian woodland vegetation. A biological and sensitive species survey of the LCBS and surrounding areas was conducted in 1991, with no threatened, endangered, or sensitive species found (Biggs May 1991, August 1991).

Complete ecological pathways could exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways. Because of the lack of perennial surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

SWMU 65A was used for an explosives test within a concrete bunker. The intact bunker was excavated and removed as part of the VCM for the site. Potential COPECs from this test site included residual HE and metals in the soil covering the former bunker; however, no HE compounds were detected in the soil samples from this site. The site is within the far-field dispersion area of other open-detonation tests conducted at the LCETS (SWMU 65E), which included radionuclides as potential COCs.

In order to provide conservatism in this ecological risk assessment, the assessment is based upon the maximum soil concentrations of the COPECs as measured in soil samples within the first 5 feet of soil. Both nonradiological and radiological COPECs were evaluated for this assessment. The nonradiological COPECs consisted of inorganic analytes (i.e., metals). No organic analytes were detected in these soil samples. Inorganic analytes and radionuclides were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997, Zamorski December 1997) for the area were considered to be COPECs. Maximum COPEC concentrations are reported in Tables 3 and 4. Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment as set forth by the EPA (1989).

VII.3.1.3 Ecological Receptors

As described in detail in an earlier report (IT July 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. Although not expected to occur in the woodland habitat near SWMU 65A, the burrowing owl was selected to represent a top predator at this site. It is present in the grassland habitat at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995). The burrowing owl is a small raptor and, therefore, conservatively represents risk to other raptors potentially occurring in the woodland habitat, such as the western screech owl (*Otus kennicottii*).

VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Exposure in the burrowing owl from a diet of equal parts herbivorous, omnivorous, and insectivorous mice would be the same as exposure from a diet of only omnivorous mice. Therefore, its diet was modeled with intake of omnivorous mice only. Both the deer mouse and the burrowing owl were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 10 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to provide a conservative estimate of potential exposures and risks to plants and wildlife at this site.

Table 11 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 12 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Table 13 presents benchmark toxicity values for the plant and wildlife receptors. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level. For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the NOAELs for beryllium and silver for the burrowing owl.

Table 10
Exposure Factors for Ecological Receptors at SWMU 65A

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E-2[d]	3.72E-3	Plants: 100% (+ soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E-2[d]	3.72E-3	Plants: 50% Invertebrates: 50% (+ soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E-2[d]	3.72E-3	Invertebrates: 100% (+ soil at 2% of intake)	2.7E-1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E-1[f]	1.73E-2	Rodents: 100% (+ soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]From EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid Waste Management Unit.

Table 11
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 65A

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Arsenic	4.0E-2[a]	1.0E+0[b]	2.0E-3[a]
Barium	1.50E-1[a]	1.0E+0[b]	2.0E-4[c]
Beryllium	1.0E-2[a]	1.0E+0[b]	1.0E-3[a]
Cadmium	5.5E-1[a]	6.0E-1[d]	5.5E-4[a]
Selenium	5.0E-1[c]	1.0E+0[b]	1.0E-1[c]
Silver	1.0E+0[c]	2.5E-1[d]	5.0E-3[c]

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (January 1989).
[d]From Stafford et al. (1991).
SWMU = Solid Waste Management Unit.

Table 12
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 65A

Constituent of Potential Ecological Concern	Soil (maximum)	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Arsenic	1.3E+0[d]	5.2E-1	1.3E+1	4.4E-2
Barium	2.50E+2	3.8E+1	2.5E+2	9.3E-2
Beryllium	7.8E-1	7.8E-1	7.8E-1	1.3E-3
Cadmium	1.1E+0[d]	6.1E-1	6.6E-1	1.1E-3
Selenium	2.5E+1[d]	1.3E+1	2.5E+1	6.0E+0
Silver	9.0E-1[d]	9.0E-1	2.3E-1	9.1E-3

[a]In milligrams per kilogram. All are based upon dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).
[d]Concentrations are one-half of the maximum detection limit.
SWMU = Solid Waste Management Unit.

Table 13
Toxicity Benchmarks for Ecological Receptors at SWMU 65A

Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[e,g]
Inorganic							
Arsenic	10	Mouse	0.126	0.13	Mallard	5.14	5.14
Barium	500	Rat[h]	5.1	10.5	Chicks	20.8	20.8
Beryllium	10	Rat	0.66	1.29	--	--	--
Cadmium	3	Rat[i]	1.0	1.9	Mallard	1.45	1.45
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8[j]	34.8	--	--	--

[a]In milligram(s) per kilogram soil.
[b]From Efroymsom et al. (1997).
[c]Body weights (in kilogram[s]) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[d]From Sample et al. (1996), except where noted.
[e]In milligram(s) per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.435 mg/kg.
[i]Body weight: 0.303 kilogram.
[j]Based upon a rat LOAEL of 89 mg/kg/d (EPA 1998a) and an uncertainty factor of 0.2.

EPA = U.S. Environmental Protection Agency.
LOAEL = Lowest-observed-adverse-effect-level.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid waste management unit.
-- = Insufficient toxicity data.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 14 presents results of these comparisons. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

Analytes with HQs exceeding unity for plants were arsenic and selenium. The only analyte with an HQ exceeding unity for all three modeled diets of the deer mouse was selenium. Arsenic and barium also resulted in HQs greater than 1.0 for the omnivorous and insectivorous deer mouse. One analyte (selenium) resulted in an HQ greater than 1.0 for the burrowing owl, although HQs for the burrowing owl could not be determined for beryllium and silver because of insufficient avian toxicity information for these elements. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). All receptors had HIs greater than unity, with a maximum HI of 30 for the insectivorous deer mouse.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 65A. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions provide more protection to the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of maximum measured analyte concentrations in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998).

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Table 15 illustrates risk estimates associated with exposure of each of the receptors to background concentrations of the metal COPECs. With respect to plants, an HQ greater than unity was obtained for selenium. HQs greater than unity were also obtained for the omnivorous and insectivorous deer mouse exposed to arsenic and barium. Selenium also resulted in an HQ greater than 1.0 for the insectivorous deer mouse. No HQs greater than 1.0 were reported for the burrowing owl from background exposure. For barium, background accounted for approximately 98 percent of the maximum measured concentration and the average barium concentrations at SWMU 65A (227 mg/kg for the samples collected outside of the bunker prior to the VCM and 160 mg/kg for the samples collected after the VCM) were less than the background screening value (246 mg/kg) for this element. Therefore, most of the risk predicted for barium and at least some of the risk predicted for arsenic and selenium are caused by uncertainties associated with exposure and toxicity that result in predictions of risk to ecological receptors at background concentrations of these COPECs.

Table 14
Hazard Quotients for Ecological Receptors at SWMU 65A

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganic					
Arsenic	**1.3E+0**	9.1E-1	**8.2E+0**	**1.6E+1**	6.6E-3
Barium	5.0E-1	6.3E-1	**2.2E+0**	**3.8E+0**	2.7E-2
Beryllium	7.8E-2	2.8E-3	4.9E-2	9.6E-2	--
Cadmium	3.7E-1	5.2E-2	5.4E-2	5.6E-2	1.8E-3
Selenium	**2.5E+1**	**5.2E+0**	**7.7E+0**	**1.0E+1**	**1.7E+0**
Silver	4.5E-1	4.1E-3	2.6E-3	1.1E-3	--
HI[a]	**2.8E+1**	**6.8E+0**	**1.8E+1**	**3.0E+1**	**1.7E+0**

Note: **Bold** text indicates HQ or HI exceeds unity.
[a]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
-- = Insufficient toxicity data available for risk estimation purposes.

Table 15
HQs for Ecological Receptors Exposed to Background Concentrations for SWMU 65A

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganic					
Arsenic	9.8E-1	6.9E-1	**6.2E+0**	**1.2E+1**	5.0E-3
Barium	4.9E-1	6.2E-1	**2.2E+0**	**3.7E+0**	2.7E-2
Beryllium	7.5E-2	2.7E-3	4.8E-2	9.2E-2	--
Cadmium	2.1E-1	3.0E-2	3.1E-2	3.3E-2	1.0E-3
Selenium	**3.0E+0**	6.2E-1	9.2E-1	**1.2E+0**	2.0E-1
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	--
HI[a]	**4.9E+0**	**2.0E+0**	**9.4E+0**	**1.7E+1**	2.3E-1

Note: **Bold** text indicates HQ or HI exceeds unity.
[a]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
-- = Insufficient toxicity data available for risk estimation purposes.

The most significant uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations or one-half the detection limit (whichever is greater) to evaluate risk. This results in a highly conservative exposure scenario that does not necessarily reflect actual site conditions. Barium was detected in all seven analyses performed on samples collected from outside the bunker prior to the VCM and in all three analyses performed on post-VCM soil samples. As described above, the average concentrations (both before and after the VCM) are less than background. Therefore, risks to the omnivorous and insectivorous deer mice at SWMU 65A are expected to be less than those shown in Table 15 for background exposure conditions.

For arsenic, cadmium, selenium, and silver, one-half the maximum detection limit was greater than the maximum detected concentration, and therefore, was used as the exposure concentration in this risk assessment. Among these, risk was predicted for arsenic and selenium. In the samples collected from outside the bunker prior to the VCM, arsenic was detected in one of the seven analyses at a concentration of 5.0 mg/kg, which is less than the background screening value of 9.8 mg/kg. Risks from arsenic (see Table 14) are based upon an exposure concentration of 13 mg/kg, which is one-half the maximum detection limit (26 mg/kg) from these analyses. Arsenic, detected in all three analyses performed on the post-VCM confirmatory samples, ranged from 4.62 to 4.73 mg/kg. These data support the likelihood that arsenic is within background limits at this site.

Selenium was predicted to be potentially hazardous to plants, mice, and owls at the site. (In the case of the owl, the HQ was based upon the toxicity benchmark for methylated selenium.) As with arsenic, selenium was in detected in only one of the seven analyses performed on the pre-VCM soil samples. This detection was at 0.76 mg/kg, which is less than both the background screening value for selenium of 3.0 mg/kg and the concentration required to produce HQs greater than unity. The detection limit for these analyses was 50 mg/kg, one-half of which (25 mg/kg) was used as the exposure concentration for the HQs presented in Table 14. Selenium was not detected in the post-VCM confirmatory samples; however, the detection limit for these analyses was 0.135 mg/kg, which is below both the background screening value and the concentration required to produce HQs greater than unity.

A further source of uncertainty in the predictions of ecological risk at this site is the assumption of an area use factor of 1.0 for both wildlife receptors. Because SWMU 65A is less than 0.1 acre in size, an area use factor of less than 0.4 would be justified for the deer mouse and an area use factor of less than 0.003 would be justified for the burrowing owl. These are sufficient to reduce the HQ for barium in the omnivorous deer mouse to a value less than unity and to reduce the HQ for selenium in the burrowing owl to less than 0.005.

Based upon this uncertainty analysis, ecological risks at SWMU 65A are expected to be insignificant. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to background risk, the exposure concentration, the use factor, the quality of analytical data, and the use of detection limits as exposure concentrations.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 65A were estimated through a screening assessment that incorporated site-specific information when available. Overall, ecological risks to the receptors are expected to be insignificant because the predicted risks associated with exposure to arsenic, barium, and selenium are based upon calculations using either maximum detected values or detection limits. In addition, average barium concentrations at the site were within the range of background concentrations, and maximum detected selenium and arsenic concentrations at the site were less than the background screening values. Based upon this final analysis, ecological risks associated with SWMU 65A are expected to be insignificant.

VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as to whether the site should be recommended for NFA or whether additional data should be collected to provide more thorough assessment of actual ecological risk at the site. With respect to this site, ecological risks were predicted to be low. The scientific/management decision is to recommend this site for NFA.

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APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land-use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. All three land-use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), excess cancer risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land-use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not currently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land-use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations

Table 1
Exposure Pathways Considered for Various Land-Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/hazard index [HI], excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
CR = contact rate for the exposure pathway
EFD= exposure frequency and duration
BW = body weight of average exposure individual
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 1E-6 for Class A and B carcinogens and 1E-5 for Class C carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land-use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

<u>Summary</u>

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Parameter Values for Various Land-Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (day/yr)	***	***	***
Exposure duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	70 adult[a,b] 15 child	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr) for noncarcinogenic compounds (= ED x 365 day/yr)	25550[a] 9125	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day[c]	200 mg/day child 100 mg/day adult	200 mg/day child 100 mg/day adult
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	260[d]	7000[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/day)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

***The exposure frequencies for the land-use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land-use scenario is 8 hr/day for 250 day/yr; for the recreational land use, a value of 2 hr/wk for 52 wk/yr is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 day/yr.

[a]RAGS, Vol 1, Part B (EPA 1991).

[b]Exposure Factors Handbook (EPA 1989b)

[c]EPA Region VI guidance.

[d]For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e]Dermal Exposure Assessment (EPA 1992).

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ADDITIONAL /SUPPORTING DATA

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